SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Science.

Vol. XII JULY 1946—JUNE 1947 Nos. 1-1

PUBLISHED UNDER THE AUSPICES OF THE
INDIAN SCIENCE NEWS ASSOCIATION
92, UPPER CIRCULAR ROAD, CALCUTTA

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HEALTH SURVEY AND DEVELOPMENT

BHORE COMMITTEE'S RECOMMENDATIONS—I

IN recent years, sanatarians had drawn pointed attention to the unsatisfactory state of public health in India. The unsatisfactory socio-economic condition in the presence of a spectre of famine now and then had also been frequently referred to. Recently a British worker (J. N. Morris, "Health for four hundred millions", *Lancet*, June 16, 1945) who had been in India during the war compared the condition here with that in England by stating that, if the English death rate obtained in India today, there would have been three million fewer annual deaths and that the expectation of life would have been above 60 years instead of 26 years. He was of the opinion that the present population pattern in India was similar in its distribution to that in England 100 years ago and that the expectation of life and other mortality data corresponded to the English experience before mortality began to fall in the latter part of the 19th century. The death rate for India was thought to correspond to the English figures before the modern public health movement got into its stride in the sixties and seventies of the last century and the birth rates to resemble those in England and Wales before the decline in fertility set in around 1880. Over 50 per cent of the deaths in India took place in individuals below 15 years, and the percentage of deaths at the age of 60 years and above was 15 (1938) compared to 60 in England and Wales.

The health problems of India were considered in some detail at the Benares Session of the Indian Science Congress in 1941 by one of the members of the Board of Editors of this Journal. A recent survey in a rural area in Bengal conducted by the All-India Institute of Hygiene and Public Health indicated that 12 per cent of the population were unwell at any given time, of which 1 per cent were acutely ill, 2 per cent chronically ill, and over 8 per cent in indifferent health. 1.6 per cent of the population were handicapped on account of one or more disabilities. The average duration of disabling illness was 50 days per sick person, or 10.6 days per head of the population. The total loss of man-days through sickness was 1,316,700. For each death that occurred, 800 man-days were lost through sickness. The largest number of man-days lost per head was in school children. It was further noted that 3.3 per cent of the wage earners were unable to work at any particular time due to acute or chronic illness and that 7 per cent could not pull their full weight owing to indifferent state of health. Sickness was, therefore, found to aggravate poverty. Clinically recognizable malnutrition was widely prevalent, leading to poor physical development, particularly in the early age period and to diminished resistance to infectious diseases. As regards the incidence of diseases, malaria constituted 61 per cent, measles 10 per cent, diarrhoeas and dysenteries 3.8 per cent, other fevers 1 per cent, and typhoid fever, influenza and pneumonia each 0.6 per cent of the total sickness. 44 per cent of the population harboured hookworm, and 3.7 per cent roundworms in the intestines; haemoglobin deficiency was widely present. The morbidity or disease rate was found to be highest in infancy. As regards environmental conditions in this densely populated area (1900 per square mile), interference with natural flooding and flushing, the poor inter-village communications, the over crowded and unhygienic houses, the low standard of general cleanliness, the existence of numerous small water pools (*dobas*), the primitive conditions with regard to the disposal of faecal matter and stable refuse, the presence of large

breeding areas for flies and mosquitoes and the unclean water available for bathing and domestic purposes could hardly be expected to support a healthy population with families of low and unstable economic status The annual loss of man days to wage earners in the area was estimated in terms of money to be Rs 1 16 000

It is clear that the simplest pre requisites of healthy living—adequate nutrition housing sanitation and safe drinking water are lacking except for certain privileged individuals in the larger cities in India There are in India today 1 doctor to 6000 people as compared to 1 to 800 in England 1 nurse to 43 000 as compared to 300 in England 1 health visitor to 400 000 as compared to 1 to 4[illegible] in England 1 midwife to 60 000 people as compared to 1 to 618 in England 1 dentist to 300 000 people as compared to 1 to 2 [illegible]00 in England and 0 24 beds per 1000 population as against 7 14 in England and Wales

Against this background the Government of India set up a Committee known as the Health Survey and Development Committee in 1943 under the Chairmanship of Sir Joseph Bhore After two years intensive labour the Committee has just presented its report in 4 volumes Volume I surveys the existing conditions volume II covers recommendations for both short and long term plans volume III contains appendices and volume IV attempts to summarize the whole report in 90 pages

The Bhore Committee accepted the following fundamental principles in planning for the future (1) that every individual had a right to receive from the State free and adequate medical care (2) that the health programme must include both curative and preventive measures (3) that there was an urgent need to develop and maintain health services for the vast rural population (4) that the health services should be placed as close to the people as possible (5) that the scheme should be so devised as to secure active cooperation of the people in all stages and (6) that the Ministry of Health in future should contain persons with an intimate knowledge of health matters who should enjoy the confidence of the public and who are thus able to secure their support in matters of legislation and administration It was also stipulated that the scheme was expected to be put into operation by the future Government of independent India and that she would be able to overhaul the existing machinery and to plan for the future without being weighed down by any consideration of sectional service communal or racial interests

The immediate objective of the Committee was to plan for 10 years in two periods of 5 years each The Committee estimated that it would involve a capital and recurring expenditure of Rs 1 000 crores for the fruition of the complete scheme The recurring annual expenditure during the first 5 years was expected to be Rs 4[illegible] crores while that during the next 5 years Rs 81 crores The annual per capita expenditure would be raised from its present 3 annas to Rs 1 3 11 during the first 5 years and to Rs 2 6 6 during the next 5 years

In planning the health structure emphasis has been rightly laid on the health needs of the tiller of the soil and the plan is visualized to be developed from the village to the urban and industrial centres

The initial focus (= primary centres) to organize would be a group of villages with about 10 000 population looked after by trained doctors public health nurses and other health personnel In the initial stages of the experiment selected units of the district will be taken up to be coordinated with secondary centres to provide for a population of 5 6 lakhs which again will be connected with the District Centre with an approximate population of 3 millions with correspondingly higher types of personnel and organization

The plan includes schemes for improving the nutrition of the people environmental hygiene the planning of rural urban and industrial housing water supplies general sanitation conservancy and drainage river and beach pollution control of insects and rodents and other carriers of disease and control of offensive trades

The problem of professional education the training of auxiliary personnel medical research and administrative organization were also considered

The first 10 year period was called the *short term plan* and the 25 years target was called the *long term plan* The long term plan stipulated an expenditure of Rs 3 3 4 per capita The Committee hoped that at least 15 per cent of the central and provincial revenues would be devoted to the fulfilment of the plan in contrast to 20 4 per cent in the United States

The existing number of hospital beds in British India which was [illegible]3 000 or 0 [illegible]4 per 1,000 population as compared to 7 4 in England and 10 5 in the United States was proposed to be raised to 153 000 at the end of the first five years and to 353,000 or 1 03 per 1 000 population at the end of 10 years At the end of the long term plan the ratio would be raised to [illegible] beds per 1 000 population It was hoped that the fulfilment of the long term programme (by 1971) would be able to cover three fourths of the population of individual districts

The Committee suggested that the district organization should from the start be established in every district in a province and that this organization should begin with 5 primary units and 1 secondary unit

and that they were expected to be increased to 25 primary and 2 secondary units at the end of the first 10 years. In the short-term programme, the establishment of the organization at district headquarters was not contemplated It was, however, suggested that the administrative and supervisory functions exercised by the staff at the Secondary Health Centre would be on the lines indicated for the long-term programme

From the above description, it would seem that the scheme could not be put into operation without the simultaneous training of technical staff and the establishment of the various types of institutions and also the simultaneous advance in other inter-related spheres, such as a forceful agricultural and industrial planning, the expansion of education, the improvement of communications and a social and cultural transformation The present lack of technical background in the administration has to be radically changed in executing such a programme It has been shown that economic advance does not automatically pay dividends in welfare but that increased income has to be judiciously employed for the execution of well-thought-out programme Whether India can produce such men and women remains to be seen Russia's forced march in this direction puts courage and hope in us. A study of Russian Welfare Schemes, therefore, merits our close attention

With regard to the organizational set-up, the Committee has tried to approach the problem at the Centre as well as in the Provinces, with the proviso that, in the impending scheme of autonomous governments for the provinces, a certain amount of power would be delegated to the Federal Administration for purposes of coordination in connection with certain aspects of higher technical education, medical research and the control of communicable diseases through air, water and land transport, and the control of the quality of drugs and chemicals Although we are in agreement with the idea that a certain amount of Federal guidance and control is necessary in order to execute a nation-wide public health programme, the Committee's recommendations will have to be modified to suit the political framework of India as it emerges from the British Cabinet Delegation's efforts Our country will do well to follow the principles which the United States of America have found useful and practicable by experience There are other questions which need consideration, *e g*, with regard to the salary scales for whole-time medical and public health technical personnel, which should be comparable on an all-India basis Apparently the Committee visualizes the abolition of private practice by doctors, but we cannot understand how this is possible in a country which still maintains its capitalistic framework. This intricate matter which is exercising the minds of many workers in other capitalistic and semi-socialistic countries needs careful consideration

The success of the scheme depends on whether all parts of India agree to level up the progress as parts of a coordinated whole The indications are, however, for a disregard of a scientific method of thinking, in preference to depending for too much on emotions and medieval ideas Whether India's population will get over these handicaps in the interest of inter-related progress is more than can be predicted at the present moment The development of a sense of patriotic citizenship is essential for the application of sound principles

In certain respects the Committee's recommendations seem to be halting and not as bold as those of the Famine Inquiry Commission recently issued Statements on progress have been hedged in by those which have no technical justification For example, while the Committee advocates training of one type of what they have called, "basic" doctors, in the same breath they state that "it might be desirable to provide fully trained doctors and less elaborate type of medical men" In spite of the fact that Russia followed this in the initial stages of her planning, there is no justification at the present moment to suggest a proposal like this Then again, with regard to the admission of students into the medical colleges, the Committee's suggestion that "one-third of the admissions to every medical training institution should be on pure merit and that the remaining seats, of which one-fourth to one-third should be for women, might be divided among all the communities", goes against the requirements of technical efficiency It is hoped that the future citizens of India will have the courage to discard these ideas and to whole-heartedly cooperate with every phase of national planning.

The whole fabric of medical and public health education should be brought directly under the universities Without university environment education cannot thrive and a research spirit cannot be fostered The Committee's emphasis on having a model all-India training institution, to be located at Delhi, cannot also be supported India's requirements for higher type of personnel could not be supplied by only one institution, as the output therefrom would be extremely small At least four such institutions should be started to cater to the needs of the north, south, east and west zones of India These training institutions will be all-India institutes sponsored by the Central authority and each of them should have a social field for participative training in medicine and public health.

The Committee has left certain essential ingredients of the scheme either untouched or

undecided, for example, the laying down of the requirements for a hygienic standard of living in terms of the objectives of different stages of the scheme, to which we shall refer later on. The production of drugs and chemicals is intimately concerned with the formulation of an Indian Pharmacopoeia. Such an urgent matter should not have been left for a future committee to decide. The Committee was perhaps compelled to leave these and other important matters over for future consideration on account of the long period already occupied by the Committee in its deliberations.

The Committee's recommendations with regard to *Medical Research* show a very poor approach. The proposals framed seem to have narrowed the scope of medical and public health research and do not constitute part of a coordinated scheme of organized research throughout the country.

There is no doubt that researches should be centralized in order to ensure coordination and to avoid overlapping. The Provinces may take up local problems, while the Centre may take up problems of an all-India character for investigation. This necessitates careful planning and coordination of various schemes of research in all branches of science, whether pure or applied. The detailed planning of research must be in the hands of those with the necessary specialized knowledge and they must be able to act without suspicion of political or racial influence.

The successful experiments made in Russia have indicated the need for a coordinated planning of research arising out of the needs ascertained first at peripheral centres, whether among the civil population, in industry, in labour camps or among the troops, and then linked up with teaching centres at universities and then ultimately with specially equipped research institutes for the investigation of problems connected with the various fields of medical and public health protection, allied with physics, chemistry, mathematics, biology, and sociology where needed. If we want to harness science to the service of man, we must revise the existing machinery of scientific education in the country from the school to the university stage. The universities which offer a much better environment for fostering a spirit of research must have the entire control of all academic institutions, medical, public health or otherwise.

In this setting, the centralization of medical and public health research has got a definite advantage in functioning as a Board under the National Research Council, such as was advocated at two successive symposia of the National Institute of Sciences of India, one held on the 27th and 28th September, 1943 and the other on the 23rd July, 1945. It was contemplated that all the existing research organizations in the country should be fitted into this scheme. The association of the different learned bodies under such a council is likely to raise medical and public health research to a higher level and will facilitate the coordination of work at university centres and at various official and non-official research institutes.

We regret to point out that the Bhore Committee's recommendations for creating a statutory Scientific Board and an Advisory Body are meant to perpetuate the existing defective machinery of the State laboratories (most of which are engaged in routine work) and the Indian Research Fund Association, which have failed to bring together to focus at different levels, universities, industries, and non-official institutes. The stature of medical and public health research will rise much higher by its close association with the proposed National Research Council. Any attempt to sequestrate it is, therefore, to be discouraged.

The population problem has been commented upon by different workers in various ways. The Bhore Committee has made certain deductions with which other workers may not agree. We shall revert to the subject later on in a subsequent issue of the journal.

As has been pointed out, the Report seems to be silent on one point, namely, the laying down of the basic requirements for a hygienic standard of living, although it has been stated that in drawing up a health plan certain primary conditions essential for healthful living must be ensured. The primary requirements of man are food, shelter, clothing, education, health, cultural recreation, security and cultural integration of the individual. "It has been observed in other countries that the raising of the standard of living to secure these primary requirements removed 75 per cent of the ills which human flesh is heir to (J. D. Bernal, the Social Functions of Science, London, 1939). It has been pointed out in our columns that these requirements for India's population cannot be met without quadrupling the income per capita of the population. Scientists and economists in India think that without absorbing at least 30 per cent of the population in industry, in contrast to the present figure of 3.5 per cent, and without reorganizing agriculture and cottage industries by forced march, this is not possible. Public health progress, therefore, forms an integral part of a comprehensive national planning. No such national planning is possible without political and economic freedom and without a willingness on the part of the people to level up conditions by a forced march and to coordinate the efforts so directed.

The authors of the Bhore Plan have fixed 1971 as the long-range target for the present, as it is difficult to visualize a public health planning beyond 25 years, for the progress at each stage will depend on the soundness of the methods formulated and the intellectual and material resources which can be harnessed to the aid of social progress. The members of the Health Survey and Development Committee have produced a blue print which merits close study by all public health workers and administrators If the plan has defects, some of which have been pointed out, and others will be referred to in future, they can be removed by critical examination and trial One point, however, has to be remembered,—any plan for public health must form an integral part of national planning, and whatever impedes its steady progress, in terms of the utilization of science to the specific needs of human welfare, should be promptly removed Herein will lie the soundness of such a planning Many commissions have been appointed in India and many useful reports have been published, but most of them have been pigeon-holed, the most important reason for which is the absence of political and fiscal freedom Now that it is in sight, it is hoped that workers in India will muster courage to devise a sound plan, to put it into practice and thus help to raise a C-3 nation to an A-1

We have given the readers our first impressions on this laborious report We shall refer to specific questions in our later issues

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ROLE OF DOMESTICATED ANIMALS IN INDIAN HISTORY

M S RANDHAWA

THERE is intimate connection between the vegetation of a country and its animals In fact, animal life is not possible without plants Only plants can manufacture carbohydrates from carbon dioxide and water with the agency of chlorophyll aided by sunlight Animals developed as parasites of plants, possibly by loss of chlorophyll Since this divergence took place in the Proterozic seas about 600 million years ago, we see interdependence in the evolution of plants and animals Fleshy seeds of Cycads and Ginkgo developed in the Mesozoic about 140 million years ago as an adaptation to distribution by Dinosaurs who ate them Bees and butter-flies have played a major role in the evolution of flowering plants in the Cretaceous about 400 million years ago, and flowers have also helped in the evolution of bees and butterflies The spread and increase of flowering plants with consequent increase in food supply promoted the evolution and development of birds in the Cretaceous and the birds in their turn helped in the dispersal of seeds of flowering trees over wider areas Grasses played a prominent role in the evolution of ungulates like horses, goats, sheep and cattle in the grasslands of Tertiary period.

The interdependence of animal and plant life which we see in geological times also continues in historical times, modified to some extent by the activities of men Animals live on plants ; they not only eat them out also seek shelter from their enemies in the cover provided by vegetation One of the reasons given for the extinction of dinosaurs in the Cretaceous period is that the plants which served as their food material had perished due to regional elevation and climatic change In human history we see the link of vegetation, animals, and man clearly illustrated Domesticated animals provide food material in the shape of meat and milk as well as power in an ancient civilization Their power value was probably more important than their food value, and the degree of development of an ancient civilization is closely related to the relative efficiency of the domesticated animals available in the country concerned The Red Indians of North America and the aborigines of Australia had no other animal available to them excepting the dog, and hence they remained in a primitive hunting stage for centuries when others had gone far ahead The Indians of Mexico, Central America, Peru and Bolivia domesticated the Llama and Alpaca for transport and developed a much higher type of civilization, the Maya culture, as compared with their kinsmen in North America Elephants, bullocks, asses, horses and camels are more efficient than llamas and alpacas and hence the Mesopotamian, Egyptian, Chinese, and Indian civilizations were far ahead of contemporary Aztec civilization Similarly we see that the Horse and Bullock civilization of the people of Heart land of Eurasia was more progressive as compared with the Buffalo and Elephant civilization of moist lands of Asia Elephants, buffaloes, asses, bullocks, horses, goats, sheep, and camel have played a great role in the development of civilization in early stages. They provided animal power which supplemented human muscle power thus relieving mankind of drudgery and providing surplus of food on account of which a leisure class arose which could think of higher

things Agriculture would not have been possible without the aid of domesticated cattle and buffaloes and a civilization based on the pick and shovel and the human muscle would have remained very primitive

DOMESTICATED ANIMALS AND THE DEVELOPMENT OF INDIAN CIVILIZATION

In the development of ancient Indian civilization, we see three distinct phases of development, which are closely connected with rainfall, vegetation, and animals available for domestication These three periods are not sharply separated like the acts of a drama, but overlap one another for fairly long periods, and it is only in their later phases that they become distinct In fact, all the actors are present all the time, and individuals among them become prominent with the changing background of vegetation which is in its turn controlled by rainfall As long as 5,000 years ago or probably earlier, the people of Mohenjo-Daro had the one-humped bullock, buffalo, elephant and the camel with them, but the camel came fully into its own many centuries afterwards when Sind had become sufficiently dry and sandy Similarly the horse established his hegemony in northern India when the droughts had converted the monsoon forest into a grassland with scattered trees, thus pushing the moisture-loving elephant further east

I PROTO-AUSTRALOID HUNTERS AND THE DOG

(C 8000 B C —C 5000 B C)

Biologists and historians generally agree that hunting and gathering of edible roots and wild fruits were the main occupation of early men when they became distinguishable from apes and had become sufficiently intelligent to deserve the egotistic appellation of *Homo sapiens* (wise man). Dairy-farming and agriculture which require far more skill and intelligence developed centuries later. Man was in the hunting stage about 10,000—12,000 years ago when North America was linked with Siberia across the Behring Strait, and early men crossed over to the New World along with their packs of dogs Thus America was not discovered by the Vikings or Columbus but by the Siberian hunters long before These early Mongoloid hunters who became the ancestors of red-skinned Amerindians did not find any useful animals in their new home which they could domesticate, and their socio-economic life got fixed in a larval stage of hunters and food-gatherers. While in North America they had only the dog or the intractable bison, in South America they could take the aid of Llama and Alpaca and consequently were culturally far ahead of the redskins of North America, and developed the Maya and Aztec cultures

PREHISTORIC MAN IN INDIA

Recently evidence about the presence of Palaeolithic man in Northern India has been collected by De Terra, and Hawkes De Terra found palaeolithic chipped stones from Chitta near Rawalpindi in northern Punjab, at Rampore near Srinagar in Kashmir, and at Kargil, beyond the main Himalayan range on the trade route over the Zojila Pass The stone flakes recovered from Chitta have been assigned to the Lower Palaeolithic, in the interglacial phase preceding the last major Pleistocene glaciation of Northern India about 100,000 to 75,000 years ago These flake implements from Chitta resemble those of Peking Man (*Sinanthropus pekingensis*) who is regarded as an early member of the races resembling Neanderthal or Mousterian men who wandered in Europe about 50,000 *B C* From the presence of stone flakes in localities lying across the Great Himalayan range the interesting conclusion arises that Himalayan passes have become much higher now, (the Zojila Pass being 11,300 feet now), and when Kargil Man flourished, the passes were much lower and migration across the Himalaya mountains was easy Geologists are of the opinion that the passes which have become inaccessible or difficult now were low and easy and mark some of the most ancient routes trodden by early man That the Himalayan mountains are still rising is a common belief among geologists. They have risen appreciably since the advent of Man in Northern India, and now have become a serious barrier between China, Central Asia and India Godwin-Austen is of opinion that since the advent of Man, the Himalaya has been thrown up by 8,000 to 10,000 feet Middlemiss, Wadia and later Dr B. Sahni have corroborated this evidence by their observations on the structure of the Karewas, the flat topped hills which are strewn all over the Kashmir Valley Fossil remains of water plants like Singhara (Trapa), Vallisneria, Chara which still flourish in Dal, Manasbal, and Wular lakes are found in these Karewas as high as 11,000 feet Thus these flat terrace-like mountains have been uplifted as much as 4,000—5,000 feet since the Pleistocene A great lake filled the Kashmir Valley in Pleistocene times, and along its shores wandered the Palaeolithic Man. The present lakes of Kashmir Valley, the Dal, Manasbal, and Wular are merely the shrinking remnants of that great Pleistocene Karewa Lake

All this evidence indicates that upto the later Palaeolithic age, which may be approximately as late as about 50,000 years ago, the Himalayan range was not a serious barrier and Palaeolithic men freely

wandered between China, Central Asia, Northern Iran, Afghanistan, and Northern India This central human stock threw numerous mutants from time to time which accounts for the diversity in pigmentation of the skin, and shape of skull, nose, and eyes of the races which inhabit this central land mass of Eurasia from the Ganges to the Volga It is very likely that these early men were brown in colour, and they threw out light-skinned, fair-haired and blue-eyed mutants by loss or modification of certain genes in their chromosomes in the northern regions, and darker races with flat noses, curly hair, adapted to tropical conditions in the South Pigmentation is correlated with light, temperature and humidity Great humidity, intense bright light accompanied by high temperature promote the formation of black pigments, eumelanins, and this partly explains the preponderance of black races in the humid tropics On the other hand aridity with high temperature promotes the formation of yellowish or reddish brown phaeomelanin, and we see the preponderance of yellow and reddish brown people in arid deserts of North India, Central Asia, Arabia and Northern Africa

Hunters and Food-Gatherers

In India there is little direct evidence available about early hunters who domesticated the dog from jackal or wolf or from both Guha is of opinion that Negritos with small spirally coiled clumps of hair were the earliest human inhabitants of India This dwarf dark race is still represented among the Kadars and Pulayans of Cochin and Travancore in South India, among Angemi Nagas in eastern India, and among some aboriginal tribes near Rajmahal Hills Besides the Negritos we also find another primitive race represented in India, the Proto-Australoids, very dark in colour, with flat noses, fleshy everted lips, and with wavy and curly hair This type has been identified by anthropologists among the Chenchus, Malayans, Kurumbas, and Yeruwas of South India, and among Mundas, Santals and Kols This type is found in its purest form among the aborigines of Australia, and also in Melanesia, Indonesia, and Ceylon Guha is of opinion that Proto-Australoid type is the most dominant element in the aboriginal tribes of Central and Southern India

No body knows as to when the Proto-Australoids came to India Some of the prehistoric skulls discovered in Tinnevelly district have been identified as belonging to this race This type has also been identified in the human remains discovered at Mahenjo-Daro along with Mediterranean, Alpine, and Mongoloid Alpine etunic types From the presence of Dingo type of dog in Australia, the only placental mammal in that continent which is a veritable home of primitive mammals like the Echidna, Platypus, and the Kangaroo, it is surmised that dog was domesticated by the Proto-Australoids. This event must have taken place about 10,000 years ago or probably earlier.

In Mohenjo-Daro period the domesticated dog had already developed two distinct races Marshall who discovered terracotta figures of dogs from Mohenjo-Daro concluded that the cultivators of Indus Valley had a dog resembling the Pariah, and another the modern mastiff Prashad has identified the bones of a grey-hound type of dog from Harappa, which he considers to be allied to *Canis tenggeranus* Kohlbrugge which was widely distributed in the Oriental Region in Diluvial times and was the ancestor of the Pariah dog The Harappa dog, according to Prashad, shows distinct affinities in the shape of its skull with the Indian wolf, *Canis pallipes* On the other hand, the Pariah shows distinct affinities with the Indian jackal Studer derives the Pariah from the Dingo which was widely distributed in Southern Asia in former times

These early men hunted wild horses, deers and bisons with the help of their rough traps, stone axes, and bows and arrows It is probably that jackals were their camp followers and frequented the heaps of bones of wild animals which accumulated around these early Neolithic camps It is likely that out of fun these early men captured their cubs and tamed them Young wolves were most likely captured in jungles, were kept as pets and their utility as guardians of camps and hunters was the product of generations of enslavement and selective breeding Woman whose domestication preceded that of all other domesticated animals played a very important role in developing the domesticated breeds of dogs and other animals on account of her inherent gentleness and patience Very likely these early animals became sufficiently tame to be harmless, but did not breed in captivity Only when they began to breed in captivity, and yielded themselves to selective breeding by man that they became truly domesticated and developed in intelligence and utility

These early domesticated dogs were of great help to the early Neolithic hunters, and fleet-footed animals like foxes, jackals, and hares which could be caught with great difficulty, were more easily available for the common camp pot Thus the food supply available greatly increased, and possibly this led to an increase in population of early men The domestication of dogs was a great revolutionary advance in the life of these hunters and food-gatherers and opened out new possibilities of living with more abundant and more variable dietary The symbiosis

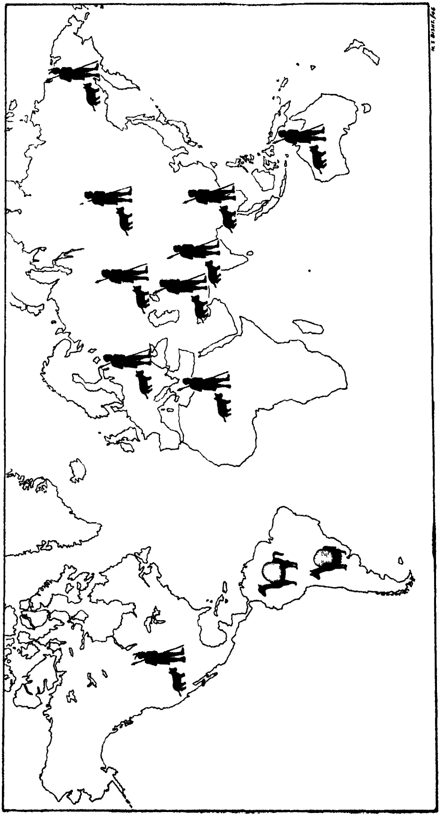

FIG 1 The Primitive Hunters and the Dog

between man and dog helped both, sharpened the intelligence of both and also meant increased food-supply for both.

II. The Peasants of Sind and the Punjab and their Buffalo and Elephant Culture

(c. 3250 B C —c 1600 B C)

There is evidence available which proves that the regions of Northern India were very wet prior to the Christian era We have archaeological evidence of the presence of evergreen tropical trees like Asoka (*Saraca indica* Linn) as far north as Mathura in the first century A D The presence of elephant and the rhinoceros (*Rhinoceros unicornis* Linn) in the present desert areas of north-western Punjab and Sind is established from pictorial seals and bones discovered at Harappa and Mohenjo-Daro from ruins which date back to 3250—2750 B C Fossils of rhinoceros along with those of Indian hippopotamus have been recovered from the Pleistocene beds of Narbada Valley Semi-fossilized remains of rhinoceros have been found near Banda and Madras Baini Prashad has identified a shoulder girdle of rhinoceros from Harappa and is of opinion that probably there was a marshy forest in the neighbourhood of Harappa in those days As late as 1505—1530 A D Babur shot rhinoceros at Begram near Peshawar, in other places west of Indus, and near Chuman , Abul Fazal records the occurrence of rhinoceros in *Ain-i-Akbari* at Sambhal and in the forests near Etawah as late as C 1570 A D At present *Rhinoceros unicornis* is restricted to the Assam plain, and about 60 years ago it was found in the Himalayan Terai as far west as Rohilkhand So far as we are concerned, rhinoceros has no other importance excepting that it serves as an index of climate

The Elephant The presence of elephant (*Elephas indicus maximus*) is established from bones and seals recovered from Mohenjo-Daro Similar seals bearing images of elephant have been recovered from Harappa From these it is likely that elephant was also tamed by the cultivators of Mohenjo-Daro and Harappa The evidence which is available is meagre, but considering the wet nature of the country, one may safely infer that the elephant, along with zebu (*Bos indicus* Linn) and the buffalo, played a major part in the economy of the cultivators and traders of Sind and the Punjab The elephant is a five-toed ungulate which is ideal for transport and soldiering in swampy jungles where horses, mules and motors are rendered useless In wet days of Northern India elephant was an ideal animal even as far north as the Punjab The elephant eats leaves of bamboos, plaintains, peepal (*Ficus religiosa*), banyan (*Ficus bengalensis*), and of various species of reeds (Typha) which flourish in swamps of tropical forests. Its principal food are leaves of rushes and reeds As there are few swamps in Northern India, reeds, rushes and bamboos have vanished and with them the elephant It may be noticed that while even a pretty land-owner can keep an elephant in Bihar and Bengal as its natural food is so abundant around jheels in these moist provinces, it is difficult even for a Raja to keep one in the Punjab The elephant served for transport of goods in civil life, and as a tank in battles It continued to hold its sway for

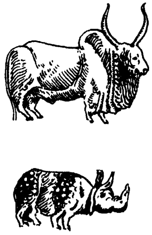

Fig. 2 The Zebu and Rhinoceros familiar to peasants and cultivators of Mohenjo-daro

long in Northern India and slowly made way before the more active horse which is less expensive to keep and is more manoeuvrable The decline of the elephant must have started from 1000 B C when the Aryan horsemen warriors invaded India The elephant as a weapon of war suffered a major defeat in 326 B C when the elephants of Poros fled in confusion before the cavalry charges of the Greeks of Alexander Since then its utility in warfare gradually declined Its present distribution is restricted to wet areas of India, the provinces of Burma, Assam, Eastern Bengal, Bihar, Terai zone of Sub-Himalayas and South India

The Buffalo—The buffalo (*Bos* (*B*) *Babulus* Linn) has played a more important role in the economy of ancient India as compared with the cow According to Baini Prashad, the Indian buffalo is the lineal descendant of the gigantic *Babulus palaeindicus* Falconer of the Pliocene age, fossils of which have been recovered from the gravels of the Narbada and the topmost beds of the Siwaliks With the remains of the extinct buffalo, *Babulus palaeindicus*, stone implements were also found in the valleys of

Godavari and Narbada by Rutimeyer, which shows that it was a contemporary of man. Hilzheimer is of opinion that the Indian buffalo had a much wider distribution as is evident from the skeletal remains discovered from some parts of Europe and its representations in ancient Egyptian and Mesopotamian reliefs. According to Duerst, *Babulus placindicus* was hunted by ancient inhabitants of Iran and Mesopotamia about 3800 B.C. when Sargon ruled over Accad. Duerst regards the Anoa buffalo of Celebes *Bos depressicornis* Smith as the most primitive buffalo which is connected with the Indian buffalo *B. bubalis* through the Mindoro buffalo *Bos mindorensis* Nende of the Philippines. It is probable that the local varieties of buffalo were domesticated in different places where they were found. The present restriction of the Indian buffalo to the Oriental region is probably due to desiccation of North-Western Asia.

Wild buffalo is found in Assam, Sunderbans, Himalayan Terai, Central India, and Ceylon. Blanford suspects that these are not truly wild, and are descendants of escaped animals. There is a parallel case of buffaloes running wild in the Philippines and on Melville Island off the coast of northern Australia. Its present distribution is restricted to swampy jungles. About the third millennium B.C., it was probably common in the Indo-Gangetic jungles.

Baini Prashad is of opinion that one of the centres, if not the sole centre, of its domestication in India was the Sind Valley. He has described a horn and some jaw-bones of the Indian buffalo from Harappa. From this evidence it is clear that the Punjab and Sind are the home of the early domesticated buffalo. Even at present it is more common than the cow in the Punjab and is valued more on account of its higher milk yield and its greater fat content. Its love for water betrays its original home in the swampy jungles of the Punjab and Sind. Even now in wild form it is never found in the mountains. The buffalo has played a more important role in the economy of ancient India, as the female gives plenty of milk and the male is ideal for ploughing muddy rice-fields and for transport in wet places. While the elephant and the rhinoceros have vanished from northern India, the buffalo continues to flourish, and is a living reminder of the wet days of the Punjab and Sind.

III. The Horse and Cow Culture of Aryans (1600 B.C.—700 A.D.)

The Horse.—There is no evidence about the presence of the domesticated horse in India prior to the invasion of Aryan nomads about 1600 B.C. We do not find any figure of horse in the seals of Mohenjo-Daro and Harappa, nor any bones have been recovered.

Peake and Fleure are of opinion that the horse was first tamed in the Steppes of Central Asia and South Russia. This immense grassland runs from Galicia, South Russia around the Caspian Sea, Russian Turkestan, with a narrow extension reaching the Sea of Okhtsk. The west part of this steppe was inhabited by descendants of Solutrean men, while the eastern part, for long uninhabitable due to glaciation, was later on inhabited by Mongols. Probably the horse was tamed by the inhabitants of these steppes, where Przewalski's horse is still found wild. Though we have no positive evidence of the horse before 2000 B.C., it is inferred that the horse was domesticated before 5000 B.C. along with other animals.

In India the domesticated horse was brought by the Aryan invaders about 1600 B.C. These Kshatriyas or horsed-warriors defeated the elephant-armies of the natives of India. Their advantage lay in superior weapons of warfare, the trained horse and the sword. As Peake and Fleure remark, "the taming of the horse for war, and of milch-mares as a source of an exceptionally complete food must have worked an immense advance, giving the herdsman a power over great spaces, and enabling him to organize vast stretches to gratify his ambitions and to meet his needs." After acquiring command over the horse, the nomad horse-men marched into peripheral fertile lands of Iran, Mesopotamia, Southern Europe, India, and China, probably driven by a drought. The domestication of the horse caused a great crisis in human history which may be compared to the invention of the steamship and later on of the aeroplane in modern times. The ancient civilizations of India and Syria, based on the elephant, buffalo, zebu and the ass, were shaken to their foundations and ultimately crumbled before the onslaught of the horse and the sword. The horse was used by the Aryan nomads for management of herds of cattle, sheep and goats in the grassland of the southern steppe, and it served a new purpose in the peripheral fertile lands. The Aryans found that not only sheep and goats but subject people can be just as well controlled with the aid of the horse. If a rebellion broke out, it could be more speedily crushed than was possible with the aid of the elephant.

The horse conquered Northern India and finally demonstrated its superiority in warfare over the elephant in 326 B.C. when Alexander invaded the northern Punjab. By the Kushan period about first century A.D., the horse had established his superiority over the elephant as far east as Mathura. On a lintel discovered from Mathura we see a procession

of horses with the elephant humbly following behind However, the acme of the horse period reached in the thirteenth century under the Mongols whose horse empire stretched from the Pacific Ocean to the Black Sea. From fourteenth century onwards we see the importance of land transport decreasing as compared with sea transport with the improvement of the sailing ship The final military use of the horse was made by the Marathas of Shivaji in the close of the seventeenth century and they played a conspicuous role in the dismemberment of the Moghul empire From eighteenth century onwards the role of the horse as an empire builder and empire destroyer had ended and the sailing ship and finally the steam ship and cannon had placed the future of the world in the hands of the Europeans

FIG 3 A procession of Horses with the Elephant humbly following —Kushan Sculpture, 1st Century A D

The Ox and the Cow —White buffalo takes delight in swimming in ponds and wallowing in mud, the ox and the cow have an aversion for water and never bathe in ponds This indicates their origin in a dry environment and they could not be natives of monsoon jungles of India The ancestor of present day cattle, *Bos primigenius* Bojanus, roamed all over Europe and Asia excepting the peninsulas of Arabia, Hindustan and Malaya in the Pleistocene *Bos primigenius* Rutimayer was prominent in the rich Sivalik fauna of Northern India Slowly the European and the Asiatic members differentiated, the former having forward-pointing horns, while the latter had inward pointing horns Falconer and Cautley found a wild variety of *Bos primigenius* which they named as *Bos nomadicus* of the Indian Pliocene The cow and the ox were domesticated in the mountainous country of Afghanistan and Central Asia, probably earlier than the horse Peake and Fleure are of opinion that the cow could have been only tamed by people of mild and gentle manners such as those who live in mountains It may, however, be mentioned that the present day Afghan living in a dry country is by no means mild, though his ancestors in the comparatively wet phase of their history were certainly milder, otherwise they would not have gone in for Buddhism with so much zeal and ardour The domestication of the cow must have taken place before 5000 B C , for we find the existence of a dairy cult at Ur in Mesopotamia at about 4000 B.C

Humped bulls and cows are frequently seen in the seals of Mohenjo-Daro and Harappa as long ago as 3250—2750 B C Ram Prashad is of opinion that the Indus people had domesticated the humped Zebu There is no support for this view excepting the fact that domesticated humped cattle were found at Mohenjo-Daro about 3250 B C Domestication is a long process and it must have been started 2-3 thousand years earlier It might very probably have been done in the mountainous regions of Baluchistan, Iran and Afghanistan Considering that, according to the work of Vavilov, this region was one of the centres of origin of cultivated wheats, it is likely that it was also the original centre of domestication of the humped Indian domestic cattle Its appearance in the Sind valley two thousand years later appears to be a subsequent event

The art of food production by means of ox-drawn iron-pointed plough was brought to India along with the horse by the Aryans about 1600 B C The warrior herdsmen of Central Asia introduced a more efficient method of food production in India, and their dominance over the Elephant and Buffalo civilization of ancient India is as much due to ox-drawn iron-tipped plough as to the horse It may, however, be mentioned that they did not regard the cow as sacred, and bulls and heifers and horses were sacrificially eaten

IV THE CAMEL AND GOAT CULTURE OF SARACENS

(632 A D —1700 A D)

The Camel and the Arab Horse —The camel and the Arab horse, both inured to thirst and hunger, played an important role in the rise and spread of Islam from the plateau of Arabia. Before dealing with the rise of Islamic Camel and Goat Culture, let us examine the geological history of the camel

The ancestor of the camel was about the size of a blue-bull, and during the Eocene period these primodial camels known as Pantolestes were common

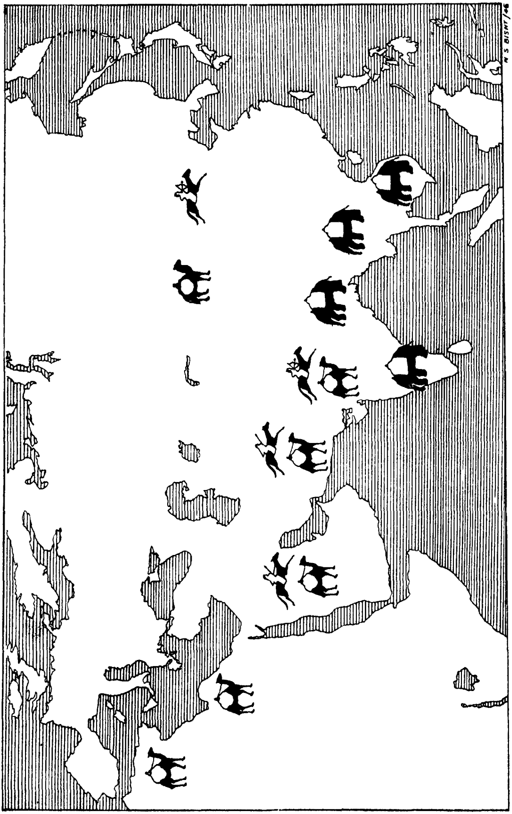

Fig 4 The onslaught of the Arab Horse and the Camel on India, and the retreat of the Elephant

in North America. During that period the Old World was joined with the New World and free interchange of animals could take place According to Cope, these primitive camels appeared in the Old World in late Miocene During the Ice Age, camel had reached Siberia. While the camels prospered in their new home in the Old World, they became extinct in America, the land of their birth Fossils of a camel (*Camelus sivalensis*) have been described by Falconer and Cautley from the Siwaliks of Northern India. The Indian one-humped camel, (*Camelus dromedarius* Linn) is a descendant of the Siwalik camel Remains of the camel have been discovered from Mohenjo-Daro and Harappa Baini Prashad is of opinion that the one-humped camel was domesticated by the people of the Indus Valley Another centre of domestication of the one-humped camel is in North Africa The two-humped Bactrian camel is a native of Central Asia, and has been found wild near Lob Nor, and was probably domesticated in that region

The camel is essentially a desert dweller and came into its own only when the Afrasian steppe land had dried up Figure of a camel has been found in a First Dynasty tomb in Egypt The camel appeared in Mesopotamia about 1000 B C However, it was many centuries later that the camel achieved any importance Peake and Fleure state that the famous breed of drought-resistant Arab horses was evolved in Nejd, the central oasis of Arabia, after the days of Roman empire, about the close of the fourth century A D It was about in this period that the camel began to be used as a ship of the desert The peculiar structure of its stomach with devices for storage of water and gobbled up food enables the camel to pass many days without food and water

The camel and Arab horse have played as great a role in the phenomenal rise and spread of Islam as its social revolutionary programme of equality and fraternity. The geographical situation of Arabia proved as much as a boon to renascent Islam between 600-1300 A D, as was the situation of England between Europe and America from 15th to 20th centuries Arabia was situated between the old civilizations of India, Iran, China, Mesopotamia and Egypt, and any power which could control this Arabian bridge between the Orient, Europe, and Africa could also control the vital trade-routes and the trade In the beginning of the Christian era, the main occupations of the Arabian tribes were camel and sheep-rearing, robbery and trade The game of robbery gave them soldiering experience which ultimately proved the cause of their triumph over the peace-loving cultivators of Mesopotamia, Iran, Egypt and India. The rigid monotheism of Mohammed who swept away a vast array of tribal gods gave the Arabian tribes unity, thus bringing to a close the internecine civil war which had ravaged the peninsula for so long. The Arab horse proved a formidable weapon of warfare in the drying peripheral lands, and the cavalry charges of Arabs broke up the armies of Iran, Egypt, Rajput India, Byzantium, and Spain. The area conquered with the aid of the Arab horse was consolidated with the aid of the camel The deserts no longer remained a barrier against human intercourse The mastery over the camel stimulated intercourse between China, Iran, Mesopotamia, Egypt, Arabia and Europe, and promoted trade Trade has played a great role in the fusion of culture and interchange of ideas. A trader acquires a broader outlook and sheds local prejudices by meeting people with different customs. Trade sharpens critical faculty and thus opens the gate of knowledge and progress As M N Roy observes, "Toleration for strange things, the attempt to understand them, freedom from prejudice, faculty of observation, ability to think in abstract—all these qualities acquired by the trader, thanks to the nature of his occupation, go into the making of a philosophical outlook" The heavy taxation and misrule of the Byzantine empire diverted the Chinese trade to Arabia, and the tribes flourished as never before. Islam gave them unity, the profession of robbery gave them military training, and with the revolutionary doctrine of equality and fraternity of man, they conquered the decaying class-ridden Byzantine empire, priest-ridden Egypt and Iran, and caste-ridden India The Arab traders and warriors gave asylum to scientists, philosophers, and thinkers escaping from the tyranny of Christian theologians, and Zoroastrian priestcraft When lamps of knowledge had gone out in India, Iran, Egypt, and Europe, the Arabian torch was burning brilliantly and it continued to burn for 500 years from seventh to the twelfth century Chemistry, Algebra, Astronomy, Optics, and Medicine flourished in the university towns of Basra, Baghdad, Cairo and Cordoba Avicenna (980-1037 A D) made numerous contributions to the science of medicine, and Averroes (1126-1198 A D) by separating the religious truth from scientific truth, liberated the human mind from the thraldom of religious dogma, and firmly established the scientific method Knowledge can only be acquired through observation rather than from speculation, however subtle, and never from authority of old books, however ancient or holy As H G Wells so rightly remarks, "if the Greek was the father, then the Arab was the foster-father of the scientific method"

How the animals and plants which form a part of a people's environment affect their language, outlook, economic and social life is also interesting. The guttural sound of Arabic language bear a

peculiar resemblance to the babbling of a camel As the wealth of a desert nomad consists of camels, horses, sheep, goats and date palms, the mathematical assignment of shares to parents, brothers, sisters, daughters etc, is peculiarly suitable for such communities This shows how suitable Islamic law of inheritance is for desert nomads On the other hand the exclusion of females from inheritance is peculiarly suitable for peasants of Hindu India to keep up the solidarity of the village community

Goats and Sheep —*Ovis vignei* Blyth which has many wild varieties in mountains from Afghanistan to Armenia is probably the ancestor of domesticated sheep in India as well as in Arabia The people of Anau in Soviet Turkestan domesticated a variety of *Ovis vignei*, and it is generally believed that all domesticated sheep have been derived by selective breeding and crossing from the varieties found in Turkestan The inhabitants of Mohenjo-Daro and Harappa had domesticated sheep with them In Mathura sculptures of Kushan period, we find figures of goat-heads carved on pillars

The Fasang, *Capra aegagrus* Gmelin, is supposed to be the ancestor of the Indian goat Even now wild goats are found in the mountains of China, India, Afghanistan, and Central Asia Wild goats are never found in the plains, and it is very likely that they were domesticated by mountaineers of Afghanistan and Iran. In Kushan sculptures we find a figure of a goat on a pillar of a door-way

Though goats and sheep were most probably domesticated in the mountains of Afghanistan, Iran, and Turkestan, we find that they came to the plains rather early in the history of civilization and served a useful prupose in the economy of the Mesopotamian, Egyptian and North Indian civilizations They provided milk, meat and clothing to the inhabitants of the cold north, and in the mountains they were also used as beasts of burden, as they are still used in the Himalayan districts of India

The goat and the camel also played a highly destructive role in Northern India, and along with man, they were mainly responsible for the destruction of forests, which incidentally resulted in erosion of soil, and also in decrease of rainfall. The goat and the camel in course of time produced near desert conditions in Northern India by the close of seventh century A D, which were ideal for the Arabian and Afghan nomads and their Arab horses and camels

The Islamic nomadic culture of the camel and the goat came to India from 712-723 A.D when Mohd -bin-Qasim conquered Sind, which had become desiccated into a desert, was peculiarly suitable for the invaders, and was a part of India which was the nearest approach to their home-land Apart from climatic and geographical conditions, the social, political and economic conditions were also ideal for the Arab invaders The lower classes were chafing under the tyranny of Brahmans and Rajputs After the death of Harsha, Hindu civilization was in a state of decomposition In the eighth century A D, the Brahmanical counter-revolution had swept away Buddhism which too had degenerated into priest-craft However, the Brahmans and the Rajputs, by re-asserting their dominance and placing themselves at the apex of the social pyramid, paved the way for Islamic invaders The cultivators of Sind and the Punjab who were never too orthodox welcomed the Islamic invaders as liberators from Brahmanical tyranny Mohd-bin-Qasim conquered Sind with the active assistance of Jats and other agricultural communities The exploited proletarians of North India embraced Islam in large numbers to escape from the tyranny of Brahmanism and to enjoy the privileges which the religion of the conquerors conferred on them Thus we see the gradual dominance of the monsoon land of India by the culture of the Arabs which was based on the Arab horse and the camel The warriors and traders conquered the peasants and priests They remained dominant for 700 years from C 1000A D to C 1700 A D until they were conquered and ousted by European traders who came by a sea-route The sailing vessels of the sea had established its dominance on the ship of the desert, and world trade began to flow in much greater volume on the surface of the Atlantic and the Indian Oceans

THE RIGHT APPROACH TO PSYCHOLOGY *

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IT needs no extraordinary powers of observation on the part of any one to realize that in 1946 we are living in circumstances which are radically different in many respects from those prevailing in the pre-war period The very foundations of our social customs, the basic beliefs and ideologies of our social structures, even our conceptions about the relation between man and man have all been violently shaken, and some of them have even collapsed completely In our efforts to keep our bearing some of us are desperately sticking to our old modes of thought and activities, while others are totally losing themselves in the currents of untested novel theories and adapting behaviour patterns of uncertain pragmatic values Political and social reformers seem to be alive to the dangers of both these steps, and consequently they are now busy devising means in order that the course of future events may be controlled to some extent and directed properly 'Planning', therefore, is in the air now Agriculture, economics, industry, education, all are subject to this planning It may be safely said that this conscious planning will henceforth serve as an active force in influencing the tempo and direction of social development

There is one underlying assumption in all these plannings, sometimes expressed but often unexpressed, that the psychology of those peoples for whom the different plans are formulated should not only be given the primary consideration but should form their only real and stable foundation It is realized now that a logically perfect plan may completely fail to achieve its end if it is unsuited to the psychological characteristics of the people for whom it is meant It is for this reason as also for the positive contributions that have been made by the science in our understanding of the motives of man's individual and social behaviours that a knowledge of psychology is beginning to be considered as an indispensable intellectual pre-requisite for all who take up the task of planning The subject of psychology accordingly is being given increasing importance in the curriculum of university studies

Psychology thus suddenly finds itself burdened with onerous responsibilities It is called upon to face concrete problems and suggest practical solutions It is called upon to tackle short range pressing problems as also to build up adequate psychological foundations for long range schemes It is called upon to deal properly with critical political problems, meet satisfactorily acute social situations as well as to treat intelligently individual mental infirmities Will psychology be able to discharge its responsibilities in a satisfactory manner? Is it in a position to meet all the demands that are made on it and the increasing demands that are bound to be made in the near future? These are certainly vital questions for all of us who claim to be students of psychology What will be our answer?

It is when we begin to ponder over the demands made on us, that the question of right approach to psychology comes to the forefront Let us say at once that the traditional philosophical way of approach to the study of psychological phenomena will not lead us anywhere near about the solution of current psychological problems Close deductive study of mind and acute logical analysis of its functions are certainly intellectual operations of a very high order, but they are of value only in assessing the intellectual capacity of the person pursuing such methods and not in solving concrete problems And if we happen to start from unverified major premises, all the intellectual labour spent in such subtle studies becomes a mere waste Our attention has now been directed to the hitherto assumed major premises of our science, and it has been brought home to us that for the verification of these premises which are now being challenged we have to fall back, not on further logic but, on actual observations Mere theoretical elaborations will not enable us in the least even to form an adequate idea of the complicated functions of the mind, not to speak of rendering help in any concrete psychological situation Here then is a definite indication that we should re-orient ourselves and take a thoroughly scientific and practical attitude in our approach to psychology Let us remind ourselves that logical systematization does not necessarily guarantee truth, for then we may be compelled to subscribe in many cases to that perverse definition that "truth is consistent falsehood" The test of the truth of a theory lies in its ability to explain facts and in its powers of prediction We have to study first of all psychological facts and then formulate theories on the basis of the materials studied An ounce of fact, it is said, is worth more than a ton of theory

It need not be assumed that the above statements have been made with a view to disparaging all theoretical studies Theory and practice certainly intermingle at every step and, therefore, theoretical

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studies cannot be abjured altogether in any science even in definitely practical sciences. What we desire to emphasize, however, is this There are still many amongst the educational circles here, some of them having considerable influence, who either openly or surreptitiously express their contempt for those who manifest a tendency to study psychology from the scientific standpoint This is an attitude which we maintain is definitely prejudicial to the progress of psychology Studied under such an attitude, psychology will never be able to play the part that is expected of it in the task of rebuilding the future society What is more, it will not be able either to contribute one single new element towards even our theoretical understanding of the nature and functions of the mind

It may be argued that we have already adopted the scientific standpoint in psychology Indeed it was a memorable day when Wilhelm Wundt founded the first psychological laboratory of the world in the year 1879 at the University of Leipzig All honour to Wundt and the first batch of pioneers in the field of Experimental Psychology,—Titchener, Kulpe, Angell, Menmann, Munsterberg, Cattell, to name only a few No one, except perhaps the logicians posing themselves as psychologists, can doubt the value of the rich contributions that they have made But to hold fast to the methods followed and doctrines enunciated by them at the present juncture would be an evidence of that regression about which psycho-analysts have taught us so much Persistent refusal to recognize psychological facts discovered by following methods other than the Titchenerian one can lead to one conclusion only, *viz*, that the situation in psychology is one of pathological fixation

The analytical method of Titchener enables us to understand more fully the structure of our consciousness We have acquired considerable knowledge about the nature and number of the constituent elements of the mind and have learnt how to make finer and still finer dissection of the pattern of a momentary state of consciousness The introduction of this essentially scientific and analytic method was necessary in order to make psychology stand on its own legs as a science That objective has certainly been gained and psychology is being studied now in all advanced universities as a scientific subject.

Times, however, have changed and the value of a science is judged now not only by its ability to explain phenomena but by its utility in rendering service to humanity, perhaps more so by the latter than by the former And the demand for more light and better guidance was never so keen as at the present time After the war utter confusion prevails everywhere and a science which cannot immediately help us in bringing at least some order out of this chaos has little chance of being recognized and paid any attention to What the psychologists should realize is that they are in a good position to offer ample assistance only if they change their traditional outlook and approach their science in the way demanded by the exigencies of the present circumstances.

Let us then loosen ourselves from the fixation point of Titchenerian analysis and move forward to adjust ourselves to the changed environment We are all agreed that whatever step may be taken by any authority, Government, Corporation, non-official organization or private associations, should have one objective, *viz*, the benefit of a mass of men, the benefit of the society and the community as a whole Therefore, it is necessary to understand how a society as a whole or a community of people think, feel and act Any given society is influenced very much by its own customs and traditions, superstitious ideas and religious sentiments etc on the one hand, as also by its dominating personalities on the other It is all the former which have been brought into the melting pot by the war and, therefore, the latter, *viz*, the leaders, have thrust upon them responsibilities of a very serious nature The making or the marring of the future society depends to a very large extent on them Studies of the influence of customs and traditions, of group behaviours, of mass actions, of leadership, etc, belong to the domain of social psychology Social psychology, therefore, should now be given the first consideration in all curriculum of psychological studies Hitherto we had been too individualistic in our outlook and neglected the social behaviours of men The right approach now would be to reverse this procedure and to reach the individual through the society The social conditions influencing the individual behaviours had not been adequately considered in Titchenerian psychology They should now receive greater emphasis Fortunately we have been much enlightened by the discoveries of psycho-analysis regarding the subtle manner in which various social factors influence, at different stages, the development of the individual mind The utilization of the materials gathered by psycho-analysis will certainly speed up the task of improving the social environment and establishing healthier and more harmonious relations between man and man Instead of being contemptuously set aside out of a sense of prudery and false purity psycho-analysis should be more widely studied and greater efforts should be made to understand its principles and utilize its findings

Even when we are studying the individual, the right point of view is no longer to subject him to laboratory experiments and ask him to give his introspections It is on the other hand to find out by methods of interview as also by the application

of tests, to determine what he is capable of doing, what function he is best able to fulfill in the scheme of society. Should he be a lawyer, a surgeon, or an engineer? Has he got the necessary mental equipments to be a military officer, an air pilot, a foreman, or a manager of a big industrial firm? Society demands immediate answers to those questions from the psychologist and he would, therefore, do well to give them his earliest consideration. Every psychologist now should be familiar with the various tests and techniques devised by those described as applied psychologists. By helping to post suitable men in suitable jobs, psychologists will certainly help in bringing back much of the peace that has been lost and eliminating much of the unrest that prevails in the present social structures all over the world. And that certainly is doing a great deal. We do not of course claim that we can regain the paradise that has been lost, but we do maintain that an approach to psychology on the lines indicated above will certainly enable us to raise ourselves a little out of the pandemonium we all find ourselves in.

ORIGIN OF THE "LIGHT EFFECT"

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A REMARKABLE effect of light on the discharge current in an ozonizer tube described as "A New Light Effect" has been reported by S. S. Joshi and his co-workers.[1] Briefly, the effect is as follows. A silent A. C. discharge, say at 10,000 volts and 50 c.p.s., is passed through an ozonizer containing some gas. (Fig. 1). The discharge current flowing is of

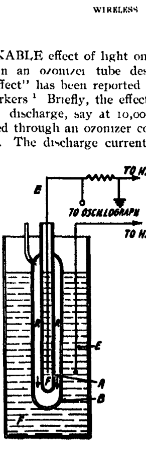

FIG. 1. Illustrating the ozonizer tube. The A. C. flows through the condenser system as shown in Fig. 2. The liquids in the containing vessel and in the central tube serve to lead in and out the current via the electrodes E E.

the order of a few tens of micro-amps. If the ozonizer tube is exposed to light (visible, including red), the intensity of the current decreases markedly. Under optimum condition the decrease may be as much as 90 per cent. The effect seems strange, because ordinarily the effect of light, if any, would be to increase the ionization of the gas and hence to increase the current. The negative effect has been studied for a large number of gases, for different pressures (from 0.8 cm. to 56.6 cms., of mercury) and for different voltages (from 4 kv to 12 kv). It appears that the effect is highest in chlorine gas and at pressures of a few tens of cms. Explanation of the effect by elaborate application of Kramer's quantum mechanical theory of light dispersion has been attempted by Prasad,[2] but the author admits the inadequacy of the explanation. The purpose of the present note is to suggest a simple explanation of the mechanism of the phenomenon by taking account of the fundamental rôle of walls of the ozonizer tube in controlling the "silent discharge" in the contained gas.

If the current flowing in the discharge circuit, when an alternating voltage is applied to the ozonizer tube, is examined with the help of a cathode-ray oscillograph, it is found that the current consists of two parts: (1) a capacitative current through the condenser formed of the glass walls and the annular space between them (Fig. 2), (2) a discharge current during the part of the cycle when the voltage across the ozonizer is favourable enough. The capacitative current varies sinusoidally after the applied sinusoidal voltage. The discharge current is, however, complicated in character. Over the smooth trace of the main current, there is an envelope which consists of innumerable strong pulses of current of short duration (Fig. 3). The origin of these latter currents is as follows. As the A.C. voltage attains the spark-

ing potential, the gas enclosed in the annular space is ionized and the positive ions and the electrons produced are urged towards opposite walls by the applied field Of these, the electrons, on account of

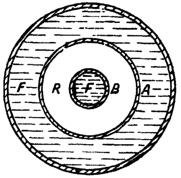

FIG 2 Illustrating the condenser system of the ozonizer The liquids F F in the container and in the inner tube form the two conducting plates of the condenser The dielectric is partly glass (A, B) and partly the gas in the annular space (R)

their higher mobility, arrive very quickly (within a small fraction of a second) on the positive wall and deposit themselves as negative surface charge. The field due to this charge neutralizes the applied field in the annular space and the discharge stops.

In course of the A C. cycle, however, the external voltage subsides and the charges in the tube become free to produce their own field. This field being high (of the same order as that due to the applied voltage) produces sparks in the gas, thereby neutralizing the charges Now, if the two opposite charges were deposited on metallic conductors, then, as usual, the neutralization would have taken place by a big spark The charges are, however, not so distributed One (the electronic) is spread on a non-conducting glass surface and the other (positive ions) is distributed in the volume rather than on the surface. The neutralization, therefore, proceeds instead by a large number of discrete pulses occurring at different parts of the surface. It is the transient currents in the circuit produced by these sparks that are observed on the smooth sinusoidal trace of the oscillogram The nature of the sparks will, of course, depend on the pressure If the pressure is high (a few tens of cms) the insulation between the positive and the negative charges is high and the sparking potential is also high Strong localized sparks are produced under such conditions and the discharge current also consists of a few big pulses. On the other hand, if the pressure is low (a few tens of mms.) the sparking potential is low and the sparks are weak but occur in greater number In this case the big pulse currents disappear and there are innumerable short pulses. The mechanism of the discharge current in the ozonizer as sketched above is similar to that proposed by Klemenc, Hintenberger, and Hofer [3] These authors, however, do not take into account the predominant rôle which the electronic surface charge, rather than the positive ions, plays in controlling the discharge phenomenon in the ozonizer tube.

It is obvious from the above that if for any reason, the electrons are unable to deposit themselves on the glass surface, the discharge current will be greatly diminished Now, the effect of light is to restrict the formation of surface charge on the glass walls This is because the electron affinity of glass surface is small and even red light has sufficient energy to detach the electrons from it. The effect of light will thus in general be to reduce the high frequency discharge current pulses This is what has been described by Joshi as "New Light Effect."

The above hypothesis regarding the mechanism of the discharge and the origin of the "Light Effect" were tested by taking advantage of the peculiar disposition of the electrode system of the ozonizer tube which produces conditions that are different for the two half-cycles of the applied voltage. When the outer electrode is positive the electronic charge is spread over a larger area than when the inner is so For the latter, however, the charge density is higher, since the field near it is stronger These conditions affect the high frequency pulses as follows For the half cycle when the outer electrode is positive, the neutralization takes a longer time since the charged area is greater The pulses, therefore, occupy a larger fraction of the half-cycle. When the inner electrode is positive the neutralization is effected more quickly, but the pulses are more intense, since the charge density is higher These asymmetries of the high frequency pulses will obviously be accentuated as the asymmetry of the electrode system is accentuated by increasing the ratio of the outer to the inner diameter of the annular space.

These deductions were experimentally verified as follow · Three ozonizer tubes (a), (b) and (c) made of pyrex glass and having different ratios of inner and outer electrode diameters were taken. Discharge was passed through the tubes from a high voltage transformer (5-10 kv) and the discharge current was made to flow through a resistance of 5,000 ohms. The voltage developed across the resistance was measured with a Cossor oscilloscope. Typical oscillograms selected from a series of studies with different pressures and different applied voltages are shown in Fig 3. The upper portions of the oscillograms correspond to the positive and the lower to the negative phase of the outer electrode.

In each pair, the picture on the left is taken in a partially darkened room ; that on the right is taken when the tube is flooded with light from a 250 watt bulb placed at a distance of about 30 cm. The length of the ozonizer tube was 20 cm. in each case

Pair (a) · Ratio of the surface areas of the inner and the outer electrodes, 1 5. This is the tube with highest asymmetry. The positive peaks corresponding to electronic charge on the outer electrode occupy a considerable fraction of the half-cycle They are, however, not very intense The negative peaks are scarcely visible, because they lasted for a very short time but were long, *i e*, intense. The effect of light in suppressing the peaks are clearly visible

Pair (b): Ratio of the surface areas 1 · 2. The electrode system is of moderate asymmetry Here,

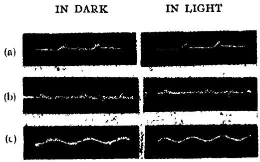

FIG 3 Oscillographic picture of the time variation of the discharge current through the ozonizer Pictures on the left are taken in semi-darkness, those on the right when the tube is flooded with light Note the asymmetry in discharge current for the two half-cycles

too, the asymmetry in the discharge current is present The negative peaks are of lesser duration than the positive ones but not so much as in the case of pair (a) Light effect is present in both the peaks in different degrees.

Pair (c) · Ratio of the surface areas 1 · 1 2 For this tube the asymmetry is small The oscillogram is nearly symmetrical. The positive and the negative peaks are almost of same duration and intensity.

It is to be noted that in all the three cases the asymmetry is largely associated with the high frequency pulses When these were by-passed by connecting a suitable condenser across the resistance, the current became smooth and practically symmetrical with no light effect. This phenomenon, together with the fact that the asymmetry in the pulses varied directly with the asymmetry of the electrode system, clearly shows that the discharge phenomena, as also the light effect in the ozonizer tube, are surface effects

In a recent paper Joshi[4] reports that with higher operating voltage the discharge current becomes asymmetric But we have found that the asymmetry is more a function of the electrode structure than of the applied potential

The control of the discharge phenomenon in the ozonizer by the electronic surface charge has a close bearing on the theory of Active Nitrogen recently proposed by Mitra[5] According to this theory, active nitrogen is simply N_2^+ ions They persist after the discharge has been cut off because the walls of the tube are so conditioned that the recombination of ions and electrons on the surface is eliminated

The above explanation of the "Light Effect" as due to the action of light on the electronic surface charge was suggested to us by Prof S K Mitra for which we are thankful to him. The theory has not yet been developed to explain all the details of the phenomenon, but it gives a satisfactory explanation of the main characteristic of the effect, namely the diminution of the discharge current when the ozonizer tube is flooded with light

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ELEMENTS 95 AND 96

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URANIUM is the last and heaviest element in the Periodic Table For a long time, it was a rather unkown element, except to scientists, and was mainly used for its coloured salts These salts found ready application in ceramics for the yellowish tint they impart to porcelain On account of its use in atom-bomb, uranium has now suddenly forced its way to celebrity It was Fermi's attempt to synthesize elements beyond uranium (No. 92) in the laboratory which, by an intricate chain of investigations, led to the atom bomb

In course of the atom bomb work, elements No '93' and '94' have been produced in a large scale by neutron bombardment of U^{238}. No '93' received the name 'Neptunium', and No '94' the name 'Plutonium', after the last two planets in the solar system Plutonium, $_{94}Pu^{239}$, has been very largely used in the atom bomb, because though it emits α-rays and becomes U^{235}, the life is long, *viz*, 24000 years, and it can be treated as fairly stable.

Announcement has been made by Prof. Seaborg, now working at the Metallurgical Laboratory of the Chicago University, that he has produced elements '95' and '96' by the bombardment of $_{94}Pu^{239}$ and $_{92}U^{238}$ with 40 M e v α-particles in the 60 inch cyclotron. Information as to what isotopes were found has not been released The reactions are probably as follows —

(1) $_{94}Pu^{239} + {}_2He^4 \longrightarrow {}_{96}Y^{243} + {}_0n^1$

(2) $_{92}U^{238} + {}_2He^4 \longrightarrow {}_{94}Pu^{241} + {}_0n^1$; $_{94}PU^{241}$ by successive β-decay is converted to element '96',—

$$_{94}PU^{241} \xrightarrow{\beta} {}_{95}X^{241} \xrightarrow{\beta} {}_{96}Y^{241}$$

The plutonium itself was obtained from the carbon pile used in the atom bomb project

What are the chemical properties of these trans-uranic elements?

Fermi who first thought that he had been able to produce the trans-uranic elements, called elements '93', '94', '95' and '96' by the names Eka-Rhenium, Eka-Osmium, Eka-Irridium and Eka-Platinum; evidently he, like many other scientists, had the idea that these elements would have the properties of the transitional group III. The electron structures are shown in parallel columns.

75 Re	$4f^{14}$	$5d^5 6s^2$	93 Np	$4f^{14}5d^{10}6s^2$	$6d^5 7s^2$
76 Os		$5d^6 6s^2$	94 Pu	.	$6d^6 7s^2$
77 Ir	.	$5d^7 6s^2$	95 ..	..	$6d^7 7s^2$
78 Pt	..	$5d^8 6s^2$	96	..	$6d^8 7s^2$

But it appears that this idea was wrong. The chemical properties of element* $_{93}Np^{239}$ (2 3 day) have been studied by a number of investigators. McMillan and Abelson have shown that it has no resemblance with rhenium, for, in acid solution it is neither precipitated by hydrogen sulphide, nor reduced to metal by zinc and has no oxide volatile at red heat. So it cannot be a higher homologue of Re, and the idea that electrons enter in this element at 6*d* shell cannot be justified.

On the other hand, these authors and many others have gathered evidences regarding the existence of $_{93}Np^{239}$ in various valency states. In the presence of a reducing agent like sulphur dioxide it is quantitatively precipitated by hydrofluoric acid (cerium being used as a carrier), but in the presence of an oxidizing agent (bromate in strong acid), it is not thrown down by this reagent In the reduced state, it is precipitated with thorium as carrier by iodate and oxalic acid and also in the basic solution, if carbonate is excluded

These evidences support the view that element $_{93}Np^{239}$, in one of its reduced states (later on recognized as tetravalent), resembles thorium and tetravalent uranium The similarity with hexavalent uranium has been demonstrated by its co-precipitation with sodium uranyl acetate. The chief difference lies in oxidation potential between two valences such that the lower state is more stable in the new element.

The similarity of element 93 with uranium led a group of scientists to conclude that, analogous to the lanthanides of the previous period, a second rare earth series starts with uranium as the first member From this point of view the element $_{93}Np^{238}$ has seven outer electrons of which six are as in uranium (four 6*d* and two 7*s* electrons), while the 7th is incorporated as a 5*f* electron.

But it was a general expectation from a study of the previous period that the new rare earth series should start at actinium

With the production of plutonium $_{94}Pu^{238}$ in large quantities and the discoveries of elements 95 and 96, the chemical properties of these elements, though not yet published, have been much elucidated. Seaborg, in connection with the announcement of the discovery of elements 95 and 96, suggests that elements beginning from actinium '89' may be

considered as a group of actinide series just like the lanthanide series of the rare earths. If such is the case, then, beginning with thorium, the $5f$ rather than $6d$ shell is being filled with successive electrons The actinide series would exhibit trivalency like lanthanides. The higher valency exhibited by Th, Pa, and U may be comparable to the anomaly shown by cerium in its display of tetravalency It has, in fact, been found that though U, Np and Pu display tri-, tetra-, penta- and hexa-valencies yet tendency towards stability to lower valency state increases as the atomic number rises As a matter of fact element 96 which has a structure akin to Gd has been found to be stable only in its trivalency So in these elements the $5f$ shells begin to be filled up, from thorium so that they form the second rare earth group

57 La	..	$5d6s^2$	89 Ac	.	$6d7s^2$
58 Ce	$4f$	$5d6s^2$	90 Th	$5f$	$6d7s^2$
59 Pr	$4f^2$	$5d6s^2$	91 Pa	$5f^2$	$6d7s^2$
60 Nd	$4f^3$	$5d6s^2$	92 U	$5f^3$	$6d7s^2$
61	$4f^4$	$5d6s^2$	93 NP	$5f^4$	$6d7s^2$
62 Sm	.. $4f^5$	$5d6s^2$	94 Pu	$5f^5$	$6d7s^2$
63 Eu	$4f^6$	$5d6s^2$	95	. $5f^6$	.$6d7s^2$
64 Gd	$4f^7$..	$5d6s^2$	96	. $6f^7$.	.$6d7s^2$

Thorium, proto-actinium and uranium are now taken away from the positions previously assigned to them, and shown to belong to the 3rd group of the periodic classification The positions of these elements as higher homologues of Hf, Ta and W were not, however, well defined Thorium oxide is basic against hafnium oxide being amphoteric, tantalum and tungsten oxides are acidic, whereas oxides of proto-actinium and uranium are basic Co-precipitation of proto-actinium with zirconium as phosphate and with thorium as oxalate is an indication of the tetravalency of proto-actinium Uranium in its tetravalency forms an important class of uranious compounds. In hexavalent state, however, uranium shows little tendency to form simple metallic salts, since UF_6 is the only compound of this sort known All other hexavalent uranium compounds are oxygenated Thorium, the first member of the second rare earth series, forms a well defined group of compounds isomorphous with tetravalent compounds of cerium; the corresponding member of the lanthanides. In case of lanthanides, the electrons penetrate into the $4f$ level, whilst even with the increase of nuclear charge, the outermost shell remains unaltered and consequently, there is a gradual contraction of atomic volume due to increasing strength of the binding force of the valence electrons. This is known as lanthanide contraction of Goldschmidt. If a second rare earth series starts with actinium, there must be a similar gradual contraction of the atomic volume with rise in atomic number The ionic radii of tetravalent thorium and uranium in Angström unit are 1 10 and 1·05 respectively. The lower value in case of U^{IV} is a significant evidence for an analogous actinide contraction which should be due to the penetration of electrons into the $5f$ level. The tetravalency of the group as has been mentioned has been stable in '94' Further, anomalous valency is also observed among the lanthanides Cerium is a typical example of being tetravalent $R^{II}SO_4xH_2O$, where R stands for Sm, Eu and Yb is wellknown.

In consideration of all these facts stated above, thorium, uranium and proto-actinium are not strangers in group III In their previous positions they had rather so long been acting as intruders awaiting the discovery of their congeners, 93 neptunium, 94 plutonium, and elements '95' and '96', and others yet to come.

The question naturally arises whether the places left vacant by Th, Pa and U will remain so One may, however, anticipate that by building up elements of higher atomic number not only the quota required by the second rare earth series will be filled up at element 103, but also by filling up $6d$ electrons the synthesis of 104 Eka-Hf, 105 Eka-Ta, 106 Eka-W, 107 Eka-Re, 108 Eka-OS, 109 Eka-Ir, and 110 Eka-Pt may be possible and the completion of the 7th period of the periodic table abruptly left incomplete by Nature may be made possible in not too far distant future

It may be noted that in the well known "Treatise on Modern Physics" by M N Saha and N K Saha, the elements from Ac are assigned to the second rare-earth group, where the $5f$-shell is being filled up (p 583) In this hypothesis, the authors were certainly influenced by their physical sense.

BEACH MINERALS OF TRAVANCORE

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TRAVANCORE beach deposits of mineral sands are, perhaps, the richest in the world They form an important potential resource of the State These deposits have not been adequately described

Monazite sand was the first mineral discovered in Travancore beach, by Schomberg[1] about 35 years ago After many years of winning minerals from the stretch of the beach round Manavalakurichi, in South Travancore, between the ancient port of Colachel and the rocky lighthouse point of Muttom, the scene of activity shifted in 1933 to the deposits north of Neendakara six miles north of Quilon At present almost all the activity is confined to this richer deposit Besides being richer in minerals, ilmenite from this area analyses a higher percentage of titania than the ilmenite from the Manavalakurichi area.

In the early years of this century a roaring trade in coir and coir products was in existence with Travancore and the continent, particularly with Germany The regions of the sea coast nearest to Neendakara, namely Chavara, Ponmana, etc , are thriving centres of coir It is a common practice of coir spinners to impregnate the coir, while spinning, with the heavy beach sand containing monazite Much of the sand, however, falls off, but some portion is well-lodged within the core of the rope Besides, as no rigorous restrictions of moisture content were then in force, a little wetting of the fibre helped the sand to stick and add its own weight to the spun rope The story goes, that when some coir godowns in Germany were emptied, the yellow grains of sand were noticed and this served to trace the mineral to the beaches of Travancore

When monazite was discovered in Travancore the demand for Thoria, for the impregnation of gas mantles, was at its highest pitch The German Thorium Syndicate practically controlled the entire output of Brazilian monazite and in competition when they reduced the price of Thoria by 40 per cent[2], the Welsbach Light Company of New York and the British Monazite Company controlled by the South Metropolitan Gas Light Company were both compelled to suspend their operations, as they could not face the German competition. The additional discovery of Travancore monazite, the thoria content of which is nearly double[3] that of the Brazilian material, also by German enterprise, strengthened the German monopoly established already.

The necessary capital for the initial exploitation of Travancore monazite was provided by Germans and the operations of the London Cosmopolitan Mining Company commenced in 1911 But when the First Great European War broke out this company was reconstituted and its full control went to Britain under the present Travancore Minerals Company.

Though Travancore monazite entered the world market, much to the detriment of the Brazil monazite, the demand for gas mantles did not last very long. Possibly with the advent of the electric lamp, the demand for gas mantles fell and with it that for monazite When the demand for monazite fell, interest developed in the other accessory minerals which accompanied the monazite A series of new products was developed consisting of ilmenite (in 1922), zircon, (in 1922), garnet (in 1936), sillimanite (in 1936) and rutile (in 1939). The latest link in this series, namely rutile, was added only recently though the existence of the mineral has been known for many years.

The writer, with the very kind and encouraging help of Mr P. A Hughes, Manager, Travancore Minerals Company, concentrated a sizeable quantity of the rare mineral, Baddeleyite, in 1936, from the Manavalakurichi sands After establishing its presence in the beach sands, further attempts to concentrate this mineral in economic quantities were made, but have not, so far, been successful Only very small percentages of other commercial minerals have been noticed, but it would be hazardous to dogmatize that no further species could be added to the existing list of economic minerals

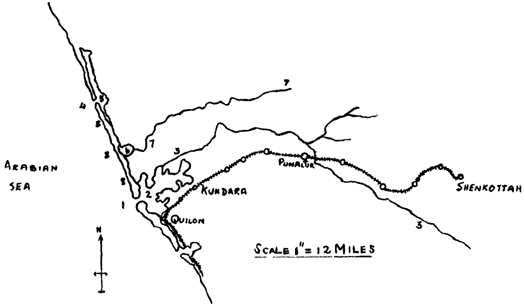
The early methods of concentrating monazite, were, naturally crude; thick yellow seams of monazite-bearing sand were scraped from the beach and sun-dried , the dried material was then tossed in shallow wicker pans by local fisherfolk (very similar to the method of separating chaff from grain) and the monazite content was boosted up by this crude winnowing. While such crude products could be shipped in those days, very strict specifications are being very rigorously enforced, at present, for the various minerals exported. An idea of this can be had from the fact that zircon concentrates are guaranteed to contain a maximum of only 0 20 per cent titania, which is the chief impurity and which when present in appreciably high percentages, renders the zircon unsuitable for the mainufacture of high temperature refractories. The methods of ore-dressing the minerals too, are as varied as the minerals concentrated. Electromagnetic separation plays an important part in the concentration of

ilmenite and monazite , zircon, garnet and sillimanite are concentrated by froth floatation , and rutile is produced by a method involving electrostatic separators, a technique which has been used for the first time in India for the concentration of minerals

II

In what form do these minerals exist in the beach? How have these minerals accumulated in the beach? What is their extent? Why is it that some stretches of the beach are richer in minerals than others? These are questions which provide problems for fascinating study The writer has no pretentions to be able to give comprehensive answers to all these questions but would only attempt to set forth what little he has been able to observe and understand in the course of his contact with the industry for some years.

All the forces of nature and their workings, for hundreds or thousands of years have taken their part, in the formation of the deposits of the minerals in the regions where we find them today These minerals were originally disseminated in the body of the gneissic rocks which form the main geological feature of the country In certain parts, these rocks have become lateritized in part ; and in certain other parts secondary sondstones have been derived from the original bed rock ; in yet other parts these rocks have been crushed and broken to bits by the forces of nature. But in whatever way the rocks undergo metamorphosis, the more resistant grains of the minerals disseminated in them are loosened from them and carried down by monsoon torrents into the lower beaches of the country and thence to the beds of streams and rivers These rivers, in their unbridled fury, not only denude the country of the minerals, but also steal away from the land, season after season, rain after rain, immeasurably large quantities of soil, much to the detriment of the fertility of the land Owing to certain natural and topographical causes and owing to the physical properties inherent in them, a portion of the minerals which are depleted from the country and carried into the sea comes back in the shape of beach minerals.



1 Neendakara Bar 2 Ashtamudi Lake 3 Kallada River 4 Kayankulam Bar 5 Kayankulam Lake 6 Vattakayal Lake. 7 Pallikkal Stream 8 Mineral Deposits

Taking into consideration the Neendakara deposits, a glance at the accompanying sketch would show a deposit rich in minerals extends from the Neendakara bar right up to the southern side of the Kayankulam bar The Neendakara bar connects the Ashtamudi Lake with the sea and the Kayankulam bar with the lake of the same name to the sea All the Mills concentrating beach minerals are situated between the Neendakara bar and the Vattakayal lake

A third lake known as the Vattakayal is situated about midway between the two lakes and a waterway connects all the three lakes The Kallada river drains its contents into the Ashtamudi lake and a stream known as Pallikkal stream, which though small, after a meandering and extensive course through the hills of Central Travancore, discharges its contents into the Vattakayal lake During the rainy season these rivers assume great sizes. When

their heavy charges of water reach their mouths in the lakes, they set up powerful movements in the lake beds, moving considerable quantities of minerals in the direction of the sea, through the Neendakara bar The high tide of the bar works against the sea-ward movements of the sands, with the result that null points are created where these comparatively heavier minerals are deposited Kayankulam bar too acts in a similar way, though to a comparitively smaller extent as the bar is not always connected with the sea The synchronized action of the two bars involving the intake of the seas and the discharge of the lakes which are themselves connected both by sea and by interior waterways, seems to help a large volume of sand containing minerals to be kept in circulation, in crab-like, up-and-down movements and remain hugged to the more accessible regions of the beach It is quite possible that Vattakayal, which is at present not connected with the sea might have once been connected with it The writer believes that a barrier of rocks in the sea running parallel to the coast acts as a ridge to prevent dissipation of the minerals into the vast sea bed and consequent dispersion and loss

The formation of the deposits in the Manavalakurichi area seems to be due to slightly different causes Manavalakurichi stands on the southern edge of a promontary which bounds the northern side of a small bay—between Colachel and Kadiapatanam The contents of a meandering stream known as Valliar which has its source in the Southern Ghats are discharged into this bay This river brings all the minerals which enrich the beach here Here too, a barrier of rocks appears to do the good work of preventing the minerals being dispersed and lost

It would therefore seem that but for the influences of certain topographical features, all the minerals so carefully collected and concentrated by the perennial work of some rivers, would have been entirely lost to us. It is quite possible that other river mouths and sea beach stretches hitherto unexplored, might have accumulated minerals under yet other conditions.

III

The basic material with which the process of mineral dressing is commenced, is called "Raw sand" in the trade It is pre-eminently black in colour and is derived either directly from material scraped from the sea beach during the monsoon months—in which case it is called "washings"—or from dunes or stretches of land adjoining the sea. "Washings" consist of thick black deposits on the wave front and is mostly a feature of the monsoon season The sea is then very rough and waves of great height and fury dash against the shore. Under such conditions the white silica sand seems to have disappeared from the beach. The sea water is grey and foamy due to the advent of the muddy waters from the country ; the strong undertow of the waves carry away the lighter silica from the heavier minerals ; and the finer grains of the lighter silica and silicates are held in suspension owing to the violent churning action of the waves Quite in contrast to the monsoon sea beach, if one examines the same stretch of the beach during the months of March and April, the difference will be striking The sea would then appear to be one sheet of blue glass set against a clear sky devoid of even a speck of cloud Gentle movements of the sea terminate in what should not really be called waves, which lap against a flat beach and seldom rise to more than a few inches in height. The sea beach then is one stretch of white silica, and hardly shows up any black grains The contrast should be seen to be believed

In view of such great difference in the composition of the beach sands during the rainy and the summer months, it is essential that a good stock of "washings" is conserved for use during summer months The raw sand from the dunes or mined from private lands adjoining the sea, very rarely equals good washings in the content of minerals As a rule they need some preliminary enrichment by sluicing or other means before being used as a feed to the concentrating plant

The mineral composition of useable raw material varies a great deal. A good washing may contain as much as 95 per cent minerals, the rest consisting mostly of silica On the other hand a poor raw material containing only 75 to 80 per cent minerals can still be a material to start with , but, the output per ton of raw sand would, naturally be lower

Of the economic minerals present in the sands the most abundant mineral is ilmenite which may constitute as much as 80 per cent of the total minerals. The next prolific mineral is zircon, followed by sillimanite, rutile and monazite in the respective order. Garnet occurs in concentratable quantities only in the deposits of South Travancore As the composition of the sands vary considerably its composition will have to be determined and checked up with the requirements of the concentrating plant. In other words the choice of the raw sand depends upon exigencies of requirements. Though there are four plants operating in the Neendakara area, only one of these concentrates all the minerals now known to be capable of economic concentration.

IV

Ilmenite.—The first step in the concentration of beach minerals is the separation of ilmenite. The

well-dried sand is first put through a vibrating screen to get rid of the coarser limeshells and trash. The screened sand is conveyed or elevated to storage bins from which the sand is fed to magnetic separators The very first operation can be adjusted to yield ilmenite, as magnetic fraction, of sufficient purity as not to need any further treatments The non-magnetic fraction would contain all the remaining minerals together with the unseparated ilmenite The ilmenite fraction is received in double-textured jute hessian bags to hold one hundredweight each and the mouths of the bags securely tied, the filled bags are then stored ready for shipment Larger consignments are shipped, in bulk, the containers being used for further fillings Smaller shipments are usually made, packed in bags of one hundredweight, the mouths of the bags being securely stitched up in this case

Ilmenite is a black mineral with a sub-metallic lustre Its theoretical composition is $FeO\ TiO_2$, but the titania content of ilmenite is never known to conform to this formula It varies between such a wide margin as 3 to 59 per cent titania A titaniferous magnetite analyzed by the writer contained 3 per cent titania, another rock sample claimed to be ilmenite from Rajputana gave a titania content of 18 per cent, a sample of black sand from the Cochin beach contained only 19 per cent titania*, a sand sample picked from the bed of a stream in Iddar State was found to be mixture of magnetite and ilmenite and the separated ilmenite analyzed 25 per cent titania; the titania content of an ilmenite collected from the beaches of Bimlipatam was over 40 per cent, Manavalakurichi ilmenite has recorded an average titania content of 55 per cent while ilmenite from areas north of Neendakara analyses anything between 57 and 61 per cent It appears, therefore, that a titaniferous magnetite may be mistaken for ilmenite and many specimens which pass off as ilmenite reporting 20 to 30 per cent of titania, are more likely to be mixtures of magnetite and ilmenite than pure ilmenite A titanium mineral reported from Nellore is claimed to have the formula $FeTiO_3\ Fe_3O_4\ TiO_2$.[4]

Such variations in the composition of ilmenite specimens are explained by Taylor[5] that " a good deal of the so-called ilmenite ($FeO\ TiO_2$) is really arizonite ($Fe_2O_3\ 3TiO_2$) and there is a further possibility that mixtures of either of these minerals or both with magnetite, occur so intimately intermingled that they cannot be freed by any commercially feasible degree of fine grinding "

It is interesting to recollect in this connection, how, many stretches of iron ore in the United States of America were left unworked, as the titanium present in these ores created slag difficulties, choking the blast furnaces[6] One of these bodies was worked successfully by the National Lead Company of New York, in 1940 The ore from the Adirondack mines[7] were ground and on wet magnetic separation yielded not only workable grades of iron-ore containing harmlessly low content of titanium, but also a sufficiently high-value titanium-bearing fraction which could be worked like ilmenite for the manufacture of titania

Production of ilmenite commenced in Travancore in 1922, with a few hundred tons The utilization of this mineral in the manufacture of titanium pigments increased from year to year till 1940, after which exceptional conditions were created by world War II The chief consumer was the United States of America and relatively small tonnages were absorbed in the United Kingdom, following the installation of a plant by the British Titan Products at Billingham in 1932[7] A proposal is in hand for the installation of a plant for the manufacture of titania in Australia[8]

Pre-war figures published by the Bureau of Mines, U S A disclose that the world production of ilmenite in 1937 was 225,000 tons equivalent to 100,000 tons of pigment, 75,000 tons of which was produced in the United States of America[9] Except for a few thousands of tons all the ilmenite came from Travancore It has been computed that the Travancore beaches have produced a million tons of ilmenite by 1940

Ilmenite has been reported in many other parts of the world, in Australia, New Zealand, Brazil, Belgian Congo, Egypt, Natal and in some parts of the United States of America Other sources of titanium are the gangus from the workings of Cassiterite mines in the Malay Peninsula, known as "amang" and the red mud residues left after the refining of Bauxite.

Titanium pigments on account of their whiteness and opacifying power are extensively used in paints, paper, rubber, leather, linoleum, plastics, ceramics, cosmetics and printing inks Unlike white-lead, titanium white is non-toxic and inert to atmospheric sulphidation which blackens white lead It also possesses a greater power of scattering light and a higher index of refraction An alloy of copper and titanium is used to purify copper castings which are said to become close-grained and free from blast holes Less important uses are in the tinting of artificial teeth and as mordants in the dyeing industry The uses of titanium compounds derived from rutile are dealt with under 'rutile' The importance of titanium minerals lies in the fact that their industrial application is in the manufacture of a large variety of products of every-day-use.

*This was found to be due to a very high percentage of black hornblende and other ferromagnetics accompanying the ilmenite The titania content of this ilmenite after being freed from these was over 45 per cent.

V

Monazite —To go back to the process of mineral separation the portion of the sands obtained as the non-magnetic fraction, after concentrating ilmenite as magnetic, contains all the remaining minerals together with the unseparated ilmenites. This is subjected to further electro-magnetic concentration to eliminate the ilmenite and the feebly magnetic residues containing the monazite treated on wet or dry concentrating tables The specific gravity of monazite* being relatively higher than zircon, rutile, and sillimanite, a good concentration can be effected by gravity methods By repeating this concentration the monazite content is raised to about sixty per cent, before further magnetic concentration in High Intensity Magnetic Separators, when monazite, which is weakly magnetic concentrates in the magnetic fraction. Further dressing on dry tables and alternating magnetic and gravity concentrations are carried out until the required purity is attained The impurities present in the final product should usually be well below two per cent

Monazite or Phosphocerite is a phosphate of the cerium metals containing thorium Monazite need not necessarily contain thorium , monazite from the Bolivian tin-fields is said to be thoria-free and the thoria-content of certain African monazites range round one per cent Though monazite has been reported to occur in many parts of the world, such as Australia, Ceylon, etc , the chief sources continue to be Travancore and Brazil Certain domestic sources of the U. S. A. chiefly the Idaho and the Carolina deposits have contributed relatively smaller quantities The production of monazite in Travancore topped 2,000 tons in 1919 but later years saw a progressive fall in the export of this mineral 1925 and 1931 registered no export at all and up to 1931 the annual export of this mineral remained well below 250 tons For some years there was a set back due to the fall in the demand for gas mantles, for the impregnation of which thoria was used , but the market for monazite was however stimulated by interest developed in the other constituents of the minerals chiefly ceria The demand for monazite therefore improved as shown by the production figures for the four years preceding the outbreak of hostilities in Europe in 1939.

Year.	*Tons.*
1936	1935
1937	3757
1938	4136
1939	5435

* Specific gravity of monazite—5 0 to 5 1, zircon- 4 5-4 7, rutile—4 2, and sillimanite—3 25 (determined at 28°C).

As has been mentioned before, the chief use to which monazite was put originally was for the extraction of thoria, for the impregnation of gas mantles , but later developments have created interest in ceria and the other rare earth oxides contained in the mineral. Cerium metal goes into the composition of a class of pyrophoric alloys commonly seen in cigarette lighters , tracer shells are said to be provided with a small button of this alloy which ignites on friction with the air and marks its own path in the air A small quantity of the cerium metal, alloyed with aluminium is said to make the latter metal better suited for foundry work Cerium compounds are employed in photography, electric arc lamps and as a catalyst in the leather industry A Cobalt-thorium catalyst has also been used in the hydrogenation of coal The oxides Prasеodymia and Neodymia are used in the glass industry

Meso-thorium is obtained as a by-product in the decomposition of monazite and is a radio-active substance identical in composition with radium Any description of the radio-active properties of meso-thorium and its application in the industry is beyond the ken of the writer An account of the radio-active property exhibited by meso-thorium is given in pages 270 & 271 in "Chemistry of Rare Earths" by S. I Levy

VI

Zircon and Sillimanite —The residual tails left after the concentration of monazite consist of two fractions, one from the gravity tables and the other from the non-magnetic residues of the High Intensity Magnetic Separators The former contains most of the sillimanite and silica and the latter accounts for most of the zircon and rutile

As mentioned earlier the composition of the raw sand at the commencement of the operations is an important factor as the composition of the tails would greatly depend upon the composition of the material used at the commencement of the dressing operations. But generally speaking, the lighter tails from gravity concentration tables yield most of the sillimanite By further gravity concentrations on wet tables, the sillimanite can be boosted to over fifty per cent. This rich sillimanite concentrate is fed to floatation cells and the sillimanite floated off when the 'floats' consist of about 85 to 90 per cent sillimanite, the rest consisting of silica, zircon and rutile. The floated product is dried and again subjected to gravity concentration and fed to High Intensity Magnetic Separators to remove the last traces of rutile. These processes are repeated until the required purity is attained The sillimanite concentrated in this manner contains a small percentage of kynite, which is identically the same in chemical composition and is therefore not considered an objectionable impurity.

Otherwise it is free from undesirable impurities of iron, titanium, and silica. The total impurities present seldom exceeds one per cent

The production of this mineral commenced in 1936 and it is produced by Travancore Minerals Company only

Sillimanite is one of the three natural Aluminium silicates of the composition, Al_2O_3 SiO_2, the other two being kyanite and andalusite All the three minerals on heating to a sufficiently high temperature change into mullite—$3Al_2O_3$ $2SiO_2$ Kyanite is transformed at the lowest temperature, expanding considerably in the process, and sillimanite is converted into mullite at the highest temperature with very little volume change

Interest in the natural silicates of Aluminium was first focussed by the ceramists of the United States of America in 1917 [9] This was as a result of the excellent results obtained by the use of artificial silicate of aluminium, in the manufacture of sparkplug cores for automobile engines The properties demanded of this small object were mechanical strength as well as ability to stand up to high electric voltages and high temperatures The outstanding success which attended the use of artificial mullite started a hunt for the natural minerals

Large tonnages of rock sillimanite under the trade name of "P B Sillimanite"[9] are being exported from India to the United Kingdom, U. S A, and many of the countries in the Continent The source of this is in Singhbhum, Bihar A still larger source of several million tons is reported to occur in the Khasi Hills in the State of Nongstoin,[9] but its inaccessibility is at present said to be preventing its exploitation The annual production of P B Sillimanite was reported to be about 5,000 tons pre-war, compared to this the rate of production of Travancore sillimanite is small A good future seems to be in store for this mineral in the coming post-war years

The use of sillimanite and allied silicates has been extended to firebricks and other refractory goods such as pyrometer tubes, electric furnace parts, thermocouples etc The incorporation of sillimanite in porcelain is said to increase the mechanical strength of the body several times that of ordinary porcelain

Zircon —To get back to the broken thread of mineral concentration, the heavier, non-magnetic tails obtained in the course of concentrating monazite consists of zircon and rutile with relatively smaller quantities of silica and sillimanite This zircon-rutile concentrate was wet tabled to remove as much silica and sillimanite as possible and the wet tabled product went into floatation cells in which the zircon was floated off from the rutile The floated zircon still contained 10 to 12 per cent of impurities, mostly sillimanite, silica, limeshells and about 1 to 2 per cent rutile The dried product was again dressed on dry tables and the tabled material run through High Intensity Magnetic Separators to remove the last traces of rutile. The resulting final concentrate contains impurities to the extent of one per cent of which titania is well below 0 20 per cent and iron as FeO, 0 10 per cent and rare earths as R_2O_3 about 0 10 per cent Particular care is taken to see that these impurities are as low as possible, as their presence in any large amounts is considered deleterious to the use of zircon as super refractories

Recent researches have however shown that zircon can be concentrated by electrostatic means This has several advantages, the chief of which are less handling and no wetting of the products.

Zircon is a silicate of zirconium—ZrO_2 SiO_2. The most important use to which zircon is put is in the refractory trade, for which the oxide is extracted Zirconia has very high melting point of over 2,500°C.[10] The ignited oxide is capable of standing up to very high temperatures and to resist the action of acids Platinum group of metals are said to be melted in vessels made of zirconia Refractory bricks, muffles, combustion tubes and a variety of laboratory ware have been made with zirconia The addition of a small quantity of zirconia to the fused quartz in the manufacture of silica-ware is said to prevent devitrification Ferro-zirconium steels were first studied by Germans. It is claimed that during the World War I Germans made armour plate with zirconium steels A zirconium-steel plate one inch thick is claimed to be as effective as three inches of best quality of other German steel [11] Ferro-zirconium is used as a scavenger of Nitrogen and its oxides from steel Cooperite, a nickel-zirconium alloy is used in making cutting tools and everbright cutlery. Other less important uses for zirconium compounds are as a pigment, in opacifying enamels and in weighting silk

A substantial fraction of the world production of zirconium minerals is met by Brazilian zirkite, a trade name for a product the composition of which is intermediate between the oxide baddeleyite and the silicate, zircon

A class of zircons of the gem variety known by the names, 'hyacinth' and 'jargoons' are quite different to the granular sands Zircon gems are reputed for their characteristic brilliance and colour.

The chief difficulty in dealing with the breaking up of zirconium minerals lies in the fact that very high temperatures are required to process them. The rapid advances in electro-thermal technique is likely to bring within easier reach the high working temperatures necessary for the processing of zirconium minerals, when their products may be expected to become more universal than at present.

VII

Rutile.—Rutile is an oxide of titanium, TiO_2, and is the latest addition to the accessory minerals. Its commercial production commenced in 1939 with a modest 150 tons. Since then the annual production of rutile has exceeded 2,000 tons. The entire production of Travancore rutile was consumed as a strategic mineral for war purposes. Statistics of world production of rutile during the years of the war therefore remained "black out". But it may be claimed without much contradiction that Travancore rutile was one of the chief sources of a reliably uniform grade and was probably the largest single source of this mineral. Brazil, again, is another important competitive source; Australia is reported to be another source; and an unkown tonnage was worked from certain domestic sources of the United States of America.

The main difficulty in concentrating rutile lies in the fact that it is usually present only in small quantities, either in sands or in rocks and to the fact that it is not known to have any outstanding property by virtue of which clean separations of it can be effected successfully, from the impurities coexisting with it. The application of the principle of electrostatic technique has, so far, proved the best method of concentrating rutile. A thin stream of the sands containing the rutile is made to fall in the vicinity of a cylinder, rod or rotor, charged with a high static voltage, when the rutile grains, charged inductively, are deflected out of the stream of sand. This deflected material is caught in a separate compartment.

But even this method is far from simple and presents a variety of practical difficulties. Much work still remains to be done and some of the practical difficulties are engaging the attention of Travancore Minerals Company which has so far produced over 6,500 tons of rutile.

The tailings containing the zircon and the rutile is the basic feed to the electrostatic separators. As the line of separation of rutile from the other minerals, is indefinite, successful production of rutile depends upon maintaining a very uniform feed to the separators, in mineral composition as well as in grain size. On this account it is essential to watch the process carefully at each stage and make suitable alterations in the flowsheet then and there. It can be realized how difficult this task is, when it is remembered that the starting material for the production of rutile is dependent upon several previous operations involved in the concentration of ilmenite and monazite. The presence of ilmenite as an impurity in the rutile raises its iron content and thereby lowers the titania and the presence of monazite introduces the most objectionable impurity of phosphoric acid. A direct handling of the raw beach sand for the production of rutile alone could never be economically feasible as the percentage of rutile which can be concentrated averages between 4 ad 5 per cent only and therefore, disproportionally large tonnages of many intermediate products will have to be handled before producing even a small tonnage of workable crude rutile.

The rutile content is stepped up in several operations intercepted by gravity concentrations which help to remove the lighter fractions of the impurities which tend to get concentrated with the rutile in the electrostatic separations.

Generally speaking a crude feed running 35 to 40 per cent rutile is a good enough feed to start with. The operation of repeated concentrations is carried out until a product containing 94 to 95 per cent rutile is obtained. The titania content of the final product now in production is well over 92 per cent. Quantities of rutile running over 96 per cent titania were produced for some years prior to 1943, but as demand for greater tonnages of the lower grade was pressed, the production of the higher grade was stopped.

The present methods of concentrating rutile are far from perfect, as the recovery of rutile now in vogue is very low, and many undesirable impurities tend to get concentrated with the rutile. Intensive work on the best methods of dealing with rutile is being carried out at present in the Travancore Minerals Company Plant.

The most important use to which rutile is put is in the coating of arc-welding electrodes. With the increased substitution of welding of steel in place of rivetting, the demand for arc welding electrodes has expanded considerably. Arc-welding was advantageously employed in the fast building of "Liberty" ships in the United States of America. The adoption of arc-welding is not confined to shipbuilding only but extends to many other trades also. Some rutile is consumed in the manufacture of some special ferro-titanium alloys. An important use of titanium minerals, possibly rutile, in the manufacture of smokescreen chemicals, was itself "smoke-screened" from the public during the past few years of the last war. The tetrachloride is mentioned as one of these.

That is the end of the story of the beach minerals and how they are extracted and used. Nothing more than a running account has been attempted. The writer is not aware of any authentic account dealing with all these minerals, their concentration and commercial uses, and would therefore feel gratified if this note will serve the purpose of providing the non-specialist with some precise information on this subject.

Commercial trends of prices and production costs are deliberately left out as the former are available

from Government statistics and the latter varies over a very wide margin, depending upon many factors such as methods of management, tonnages handled, and the number of minerals concentrated Any description of the concentrating machines and their functions are also beyond the scope of this note *

The writer would like to express his thanks to Messrs Travancore Minerals Company for granting him permission to publish this note He must particularly mention here his deep sense of gratitude to Mr P A Hughes, A M I , Mech E., Manager of the Company for not only affording all facilities for working in this new field but also for his kind encouragement at all times He is also indebted to Mr V. Wood, A R S M , Assistant Manager, Travancore Minerals Company, for valuable suggestions in the preparation of this note

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* Two important developments, since this paper was completed, deserve mention The first and the more important development is a proposal to nationalize the beach mineral industry in Travancore with the immediate establishment of a Foctory for the manufacture of titania in Travancore The potential importance of Thorium as a source of atomic energy has resulted in monazite being reserved for special consideration in line with the United Nations Policy

The second is, that after many years of fruitless search, the writer was able to discover in the course of some special experimental research work, Baddeleyite in the northern deposits of Neendakara area

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Notes and News

ROYAL BOTANIC GARDEN

THE report of the Royal Botanic Garden, Sibpur, for 1944-45 gives an indication of the importance of this department not only to the botanists, but also to the commercial public in India and abroad

Exchange of seeds and plants was one of the main feature of the activities of the Garden, during the year under review, inspite of transport difficulties While 1,545 plants and 91 packets and 21 lbs of seeds of different plants were distributed, only 62 specimens of orchids and 123 packets of seeds of other plants were received and grown in the Garden

Botanical information and materials for demonstration and research were distributed to different parts of India and abroad, *e.g* , to Egypt, Great Britain, U.S A and China Bark and plant materials sent from the Garden were used by specialists at the New York Botanical Garden for important research work connected with the World War II

Plants were raised in the Lloyd Botanic Garden, Darjeeling, from seeds received from China and U.S.A , and special attention is being given to the study of the habits and cultivation of *Atropa Belladona* The Darjeeling gardens suffered badly due to a heavy snow fall on the 5th and 6th January, 1945

Specimens were collected for the herbarium from the Singalila Range (Darjeeling District), and the reserve forests of the Terai Region (Jalpaiguri District) The major portion of the herbarium work was carried out at Darjeeling (Lloyd Botanic Garden) where the herbarium was shifted as a safety measure during the war

A sum of Rs 41,899 and Rs 79,029 were spent for the staff and all other heads respectively at the Royal Botanic Garden, Sibpur A sum of Rs 34,044 and Rs 39,966 were spent under the same heads for the Lloyd Botanic Garden, Darjeeling, while the Calcutta Gardens (Eden Gardens, etc) spent Rs. 48,038 under all heads

In the Bengal Government's Plan for Post-War Reconstruction, a scheme involving Rs 200,000 is provided for practical training in horticulture and gardening to be started at the Royal Botanic Garden, Sibpur, to meet the demand for trained gardeners and horticulturists both in Bengal and outside.

In another scheme, involving Rs 1,60,000, it is proposed to establish a Provincial Physic Garden close to the Sibpur Garden, for the collection and cultivation of common medicinal and other useful plants from all parts of the province and from outside the province as well, with a view to supplying authentic plants to the principal drug and other manufacturing concerns.

While the horticultural section of the Garden is thus receiving the necessary attention of the Government, it is really unfortunate that the activities of the Botanical Survey of India is kept in abevance owing to the absence of funds, staff, etc We have discussed at length, on the reorganization of this important survey in our leading article (*Science and Culture*, September, 1945) and we again draw the attention of the Governments of Bengal and India to the necessity of reviving the work of exploration of the Indian flora without any further delay with a view to utilizing the enormous vegetable wealth of the country

STATISTICAL SURVEY OF BENGAL FAMINE

A STATISTICAL report dealing with the economic background and after-effects of the Bengal Famine, based on the data obtained from a sample survey covering nearly 16,000 families in 386 Bengal villages by voluntary help, is published in *Sankhya, Indian Journal of Statistics*, Vol 7, Part IV, 1946

A survey of a small number of villages was carried out by the Department of Anthropology, Calcutta University, in 1943 (see *Science and Culture*, November, 1944 and February, 1945) which was based on the principle of random sampling In 1944-45, the Indian Statistical Institute, under the general guidance of Prof P C Mahalanobis and with the collaboration of Prof K P Chattopadhyaya carried out an extensive sample survey based on statistical lines

The actual position even before the famine, the report says, was precarious About one-third of the total rural families did not own any paddy land while two-fifths had less than two acres, so that about three-fourths of all the families had either no paddy land or owned less than two acres The over-all average for the province as a whole was about 1 8 acre of paddy land per rural family, which was below the subsistence level or on the border land Averaged over a number of years before the war, there was a net import of about one per cent of the total production of rice and other cereals Bengal as a province should therefore be never considered as a province with surplus rice. The average yield of rice is estimated at about 10 maunds (820 lbs.) per acre.

The sample estimate that about 480,000 people had been rendered destitutes (*i e.* persons living on charity) under war and famine conditions in Bengal and of this about 330,000 can be attributed to the famine of 1943. Total number of post-famine destitutes was 108,000 in May 1944 The number of destitute women was greater than destitute men (specially among adults belonging to the age-group 15 to 50 years). This has created a serious socio-economic problem.

Landless labour had contributed to the largest share of destitution, the chief cause of which was deaths of earners ; next in importance was sickness and then unemployment of earners

The survey shows that 66 per cent of the rural population consisting of agriculturists and agricultural labour have on an average less land than required for bare subsistance The groups most affected were 'fishing', followed by 'agricultural labour', 'craft' and 'husking paddy'. The number of fishing families reduced to destitution is six times that of the agriculturists

During the famine 260,000 families (out of 6,500,000 owing paddy land) lost their holdings and were reduced to the rank of landless labourers Out of 710,000 acres of paddy land sold during the famine only 29,000 acres were purchased back. In the villages about 420,000 acres of paddy lands passed on to non-cultivating owners residing in urban areas

The total number of plough cattle in the province before the famine, it is estimated, was just sufficient or slightly less than adequate for cultivation of the aman crop, and the loss during famine period is estimated to be 10-11 lakhs (*i e*, about 13 per cent) and this is likely to affect seriously the agricultural operations in future

There is clear evidence to show that economic deterioration had set in even before the famine and during the famine period the whole process was greatly accelerated The famine was not an accident like an earthquake but was the culmination of economic changes which were going on even in normal time

The report gives an idea of the importance of such socio-economic enquiries based on the methods of sample surveys, and what a permanent, multiple purpose sample survey organization would be able to carry out even at short notice.

The second part of this report deals with the socio-economic problems created by the famine and the necessary measures of rehabilitation and has been prepared by Prof. Chattopadhyay. Plans for rehabilitation given in this part are based on the figures and results given in the first (statistical) part. The two parts are being published in the form of a book entitled "Famine and Rehabilitation in Bengal".

INSTITUTE OF JUTE TECHNOLOGY

THE scheme for the establishment of an Institute of Jute Technology has been finally approved by the Indian Jute Mills Association and the Calcutta University.

The scheme envisages the training of 25 science students (I Sc's) every year, who will be trained for a period extending over four years, in theoretical and practical subject in the institute and in the mills, for employment in supervisory posts in the jute mills scattered around greater Calcutta

The proposed Institute will be located near the University College of Science and Technology, the cost of land, building, equipment and staff amounting to Rs. 7,30,000 will be provided by the Jute Mills' Association The University will acquire 30 cottahs of land for the purpose The Association will also provide for an annual recurring expenditure for upkeep and maintenance of the Institute estimated at Rs 1,50,000

The Institute will be managed by a Governing Body and a Technical Administrative Committee, consisting of the representatives of the Association and of the University, including the Vice-Chancellor of the University as the Chairman and the President of the Jute Mills Association as the Vice-Chairman

The Institute will fulfil a long felt need in Bengal, which is the world's chief seat of jute manufacture Accepting the gift with thanks the Vice-Chancellor (Mr P N Banerjee) said, "This is the first time in the history of industrial India that an industry has chosen to harness science to industry for the benefit of the country, to which the industry itself owes its life I am sure your example will be emulated by others".

RICE RESEARCH IN INDIA. MR K. RAMIAH

MR K RAMIAH, L Ag, M Sc, Dip Agr (Cantab.), F.N.I, M B E, Special Officer for Rice Research under the Government of India, is shortly to take charge of the All-India Rice Research Institute, to be established at Cuttack (Orissa)

Mr Ramiah after a brilliant career at the Agricultural College, Coimbatore, joined the Department of Agriculture, Madras in 1914 as a research assistant to Mr F R. Parnell, Economic Botanist at Coimbatore. In 1924 he was deputed by the Government for higher studies at Cambridge, where he worked under Prof. Engledow and his thesis on the "Tillering of Wheat" is a comprehensive work on the subject In 1929, he was appointed "Paddy Specialist" and the decade that followed saw the establishment of an active school of rice research at Coimbatore. Particular mention should be made of the application of x-rays resulting the production of remarkable mutants and of the cytogenetical work being combined with a breeding programme in collaboration with Messrs Ramanujan and Parthasarathy A comprehensive monograph entitled "Handbook on Rice" was finally published by Mr Ramiah in 1937.

In 1937, Mr Ramiah succeeded Mr Hutchinson as the Geneticist and Botanist at the Institute of Plant Industry, Indore, under the Indian Central Cotton Committee and he had to switch over to cotton after two decades of continuous work on rice The statistical evaluation of genetical factors was an important aspect of the work initiated by Mr Hutchinson, and Mr Ramiah was responsible for its further development in collaboration with Dr Panse Hutchinson and Ramiah have further standardized methods of describing crop plants (cotton and rice) from the genetical point of view

Mr Ramiah represented India along with Sir T. S Venkatraman at the International Congress of Geneticists held in Edinburgh in August 1939

He presided over the section of Agriculture of the 28th Indian Science Congress, held at Benares in 1941 and his address was a masterly survey of plant breeding and genetical work in India

Unlike other crops *e g*, cotton, jute, cocoanut, sugar and oil seeds that are controlled by the respective commodity committees, research and development in rice will be financed and controlled by the Central Government, instead by levying a cess on paddy hulled in power mills (see *Science and Culture*, April 1945, p 429)

INDIAN THORIUM AND FOREIGN INTEREST

RECENTLY the question of the industrial development of atomic energy formed the subject of a discussion in the House of Commons. In course of the discussion, it was strongly suggested that the H. M Government should take special care to acquire all the uranium and thorium ores existing in the British Commonwealth and Empire Mr Blackburry one of the participants, noted that, of the two important raw materials for atomic energy, *e g*, uranium and thorium, the latter is roughly three times as common as the former Before the war, the principal use of thorium was in connection with the gas mantle industry, Britain alone produced about 20 to 30 million mantles a year, containing about 10,000 kg. of thorium oxide Thorium for the British gas mantle industry was obtained exclusively from the monazite sands of Travancore The present concession is held by a company called Hopkin & Williams (Travancore), Ltd, in which a substantial interest is held by the Imperial Chemical Industries, England. It is of interest to note that about three-

quarters of the world's supply of thorium come from Travancore

Foreign interest in and concern regarding Indian deposits of thorium, uranium and such other minerals necessary for atomic energy developments should be very carefully watched. With the advent of the atomic age, these minerals have acquired national importance and have become unsparable strategic minerals Recently the Government of India have appointed an expert committee to investigate into the industrial possibilities of atomic energy in India. We are strongly of the opinion that an effort should now be made to revise old concessions covering thorium or uranium bearing minerals and a strict policy of not granting any such concession in future to a foreign company or government or even to any Indian company with which foreign interest is closely associated should from now be enforced

THE INDIAN INSTITUTE OF SCIENCE

THE ninth annual meeting of the Court of the Indian Institute of Science, Bangalore, was held on May 18, 1946, with Sir M Visvesvaraya in the chair In course of his presidential address, Sir Visvesvaraya referred to the work done in the Institute during the year 1945-46, the various proposed schemes of development, increased financial provision, and many important questions of applied research in India The great expansion of the Institute during the last few years was clearly reflected in the financial provision for the Institute The revised budget estimates for 1945-46 reveal an income of Rs 20 4 lakhs and an expenditure of Rs 20 8 lakhs In the session 1946-47, an approximate income of Rs 33 lakhs and an expenditure of Rs 36 lakhs are anticipated While judging these figures, one has only to remember that for twenty years prior to 1940, the income and expenditure of the Institute remained practically stationary in the neighbourhood of Rs 6 lakhs

Of the various schemes of extensions and developments, special mention may be made of the scheme for the establishment of a department of Power Engineering Last year, in recognition of the need of post-graduate study and research in power engineering, the Court appointed an expert committee, with Prof M N Saha as Chairman, to report on the subject The committee submitted a comprehensive report and recommended the establishment of a High Voltage Engineering Laboratory The Government were approached for a capital grant of Rs. 40 lakhs and a final recurring grant of Rs 4 67 lakhs to enable the Institute to give effect to these proposals The Government have accepted in principle the scheme for the establishment of a High Voltage Laboratory at an estimated capital cost of Rs 24 lakhs approximately and of Rs 45,000 recurring, and have already sanctioned Rs. 4,89,000 for the session 1946-47 to start work on the subject

Very recently a fifth course in Aeronautical Engineering was added. This is being followed by a course on Internal Combustion Engineering Preparations for equipping this department for the delivery of lectures and the training of students are now under way A course in Metallurgy is also being started Professors R. G. Harris, J. B Carter, and Frank Adcock have been appointed to take charge of these three new departments

All these developments are included in the proposed four-year plan of the Institute A deputation consisting of Sir V N Chandavarkar, Sir J C Ghosh and Mr F V Ganapati waited on the Government of India in the Departments of Education and of Planning and Development The Government have generally approved this programme of development and have provided in the budget estimates of 1946-47 an additional grant of Rs 9,70,000 (non-recurring) and Rs 2,47,000 (recurring) to the Institute representing the first year's contribution towards the four-year plan This grant is exclusive of the grant for the High Voltage Engineering Department and will be utilized for strengthening the Departments of Metallurgy, Internal Combustion Engineering, Chemical Engineering and General Chemistry, for improving the scales of salaries, etc

Referring to the progress of work done in the various departments, Sir Visvesvaraya mentioned that, under the supervision of Sir C V Raman, numerous aspects of the physical behaviour of diamond were studied and results of great interest and importance obtained The discovery of a new kind of mica with essentially different from those of known varieties has been reported from his laboratory In the Department of Pure and Applied Chemistry, work of considerable interest has been done on thermo-dynamics of gas reaction, micro-biological formation of elemental sulphur, chemistry of sandalwood oil, and a group of other cognate problems In the Department of Electrical Technology, a laboratory for ultra-short wave and micro-ray research has been organized Experimental work on the wall interference and stress distribution in elliptic bulkhead rings has been completed in the Department of Aeronautical Engineering Researches in applied Bio-chemistry mainly centered round food technology, *e.g*, preparation of vegetable milk from soya bean and groundnut along with large-scale feeding trials of the same, deinfestation of grains, reconditioning of rancid *ghee*, vitaminization of vanaspati etc. The award of overseas scholarships by the Central and Provincial Governments to almost all the senior research workers of the Institute, several of whom

have already left the laboratories, has seriously interfered with the research work in the Departments of Pure and Applied Chemistry, Bio-Chemistry, Electrical Technology and Aeronautical Engineering

THE FUEL RESEARCH INSTITUTE

THE Fuel Research Committee have just submitted their plan for the establishment of the proposed Fuel Research Institute at Dhanbad, involving a capital expenditure of Rs 14 lakhs and a recurring expenditure of Rs 2,50,000 for the first five years ultimately rising to Rs 5,50,000 Dr J W Whitakar, Ph.D, F R I S C, F Inst F, at present Principal, Technical College, Huddersfield, U K, has been appointed to the post of Director and is expected in India shortly

The decision of the Council of Scientific and Industrial Research to establish a Central Fuel Research Institute is the direct outcome of the supreme need felt for intensive research on all aspects of fuel technology in this country This need has been further reinforced by the gloomy prospect of an early depletion of coal, particularly of coking coal The Coal Mining Committee of 1937 estimated the life of the Indian coals (based on the then production figure of about 25 million tons) as follows All good quality coals—120 years, coking coal of good quality —62 years (approximately), non-coking coal of good quality—about 100 years On July 9, 1940, the Government of India appointed a Fuel Research Committee with late Dr H K Sen, and later Sir Cyril S. Fox, as chairman The Committee was subsequently reconstituted and considerably enlarged to include 14 members, and functioned under a fresh chairman Mr A Farquhar

Originally the committee had recommended the establishment of a Central Fuel Research Station Later on, however, they decided in favour of a full-fledged Central Fuel Research Institute, having the following principal functions (*a*) chemical and physical survey of Indian coal, (*b*) processing and preparation of coal with special reference to metallurgical coke, and (*c*) low temperature carbonization. Early in 1944, a small local Planning Committee was appointed to carry on the day to day work for the establishment of the Institute.

An excellent site at Digwadhi near Dhanbad (six miles from the Jharia Railway station) adjoining the Digwadhi Colliery of the Tata Iron & Steel Co, Ltd, has been selected for the Institute Situated in the heart of the major producing coal-fields of India, the site is well suited for the location of the Institute. It is within an easy distance of the Department of Mines and is within 100 miles from the Tata Iron & Steel Co., Ltd.'s works and the National Metallurgical Laboratories at Jamshedpur The synthetic ammonia plant at Sindri and the proposed hydro-electric station on the Damodar River are all very close to the site which is again only 200 miles from Calcutta

Power requirements of the Institute have been estimated at about 1000 k w which will be met in future from Sindri power plants of the Fertilizer Establishment or from the proposed grid system in Bihar. Power supply for immediate needs will, however, be available from the nearby collieries of the Tata Iron & Steel Co The Institute's daily requirement of about 50,000 gallons of water will be met from wells sunk for the purpose

The Committee have proposed the establishment of 8 main divisions including 6 technical divisions, among which the work of the Institute will be divided. The main 8 divisions are as follows

1. Physical and Chemical Survey of Coal Resources (including analytical section)
2. Carbonization and by-products (including colloids and rheology sections and liquid Fuels and Oils)
3. Chemistry Division (including hydrogenation, synthesis, plastics and coal preparation section)
4. Physics Division (including pyrometry, calorimetry, x-ray and spectroscopy)
5. Gaseous Fuels Division (including wood fuels).
6. Engineering Division
7. Library and Intelligence.
8. Administration and Office

Details of staff requirements, their scales of salary, building and floor area estimates for various laboratories, and financial requirements have been fully indicated in the plan Under capital expenditure, cost of buildings, services, etc account for Rs 11 lakhs, and laboratory equipment for Rs 3 lakhs Recurring expenditure, including minimum initial salary to the technical and administrative staff, stores, chemicals, apparatus and contingencies, and repairs and maintenance on plants and buildings, has been estimated at Rs 2 5 lakhs for the first five years and ultimately at Rs 5·5 lakhs In connection with the annual recurring expenditure, the committee have recommended the levy of a cess of one anna per ton on all coal produced in British India. An annual income of Rs. 15 lakhs for financing the Institute is expected as a result of this procedure

PRESERVATION OF ANCIENT INDIAN RECORDS

THE proceedings of the second annual meeting of the Indian Historical Records Commission which

met at Peshawar in October 1945, have just been issued in a separate volume

The conferenc planned a number of fresh measures for the collection of old records and their preservation for posterity The publication gives details of these measures which include the formation with financial aid from the Government of India of *ad hoc* and Regional Survey Committees in the provinces and States Further it has been suggested that the Government of India s Director of Archives will hereafter inspect provincial records offices and advise them on matters relating to their arrangement and safe preservation In this connection a recommendation has been made that District and Divisional records may be transferred to provincial or State centres

A five year plan of publication to be followed by a more ambitious twenty year plan has been undertaken by the Commission s Research and Publication Committee and a number of learned bodies in the country will publish important historical documents in oriental languages

The publication includes thirty seven short articles specially contributed based on documents available for the first time on various aspects of life and politics in India at different periods

THE ALL-INDIA MANUFACTURER S ORGANIZATION

THE first quarterly meeting of the Central Committee of the All India Manufacturers Organization was held on June 9 1946 at the office of the Organization at Bombay Sir M Visvesvaraya the President of the Organization in course of his address referred to the contemplated forthcoming visit of a small party of members of the A I M O to England America Canada and perhaps to a few selected European countries if possible The object of this visit is to study the changed conditions of industry and trade in those and other countries after the war and to consider the arrangements to be made for procuring capital and consumption goods as required for new industries or for consumption in this country Sir Visvesvaraya referred to the various difficulties of industrial expansion of this country most of which were created deliberately by the Government As one instance he said that the informed public in the country had always desired that industries should be a federal subject but the Government for their own reasons transferred the subject to Provinces under the Parliamentary Act of 1935 To relegate such a subject to the inexperienced direction of the provincial administration is itself proof of Governments disinclination to foster industries

The committee recognized the danger of arrested industrial development in the British Cabinet Mission s new plan of an Indian Union, which has restricted the central responsibilities to only three spheres namely Defence Communications and Foreign Affairs They have passed the following resolution

The Central Committee of the All India Manufacturers Organization urges that a strong public opinion in our country be created against restricting the Centre only to Foreign Affairs Defence and Communications as envisaged in the recommendations of the British Cabinet Mission and that the inclusion of Currency National Debt Customs and Tariffs Planning and Development and of Heavy and Key industries among the subjects to be directly controlled by the Union Centre must be secured The Committee is emphatically of the opinion that this is vitally important to the effective defence of the country and to the planned and rapid industrialization of the entire country through co ordinated regional distribution of industry under a centrally operated plan as has been constantly advocated by our Organization and adopted by the Government of India in its statement of policy issued on 21st April 1945

The following office bearers of the Organization were elected for the year 1946 *President*—Sir M Visvesvaraya K C I E *Vice President*—Mr Sankalchand G Shah and Mr S N Haji *Hony Treasurer*—Mr H P Merchant *Joint Hony Secretaries*—Mr Murarji J Vaidya Mr N D Sahukar and Mr Aziz H Laljee

THE UNITED STATES INFORMATION SERVICE LIBRARY

OUR attention has been drawn to the Library of the United States Information Service in the Public Affairs Branch of the American Mission 54 Queens way New Delhi set up by the Government of the United States with the purpose of informing the people of India of the life and institutions of the American people Reference material is provided in the form of books periodicals and United States Government publications presenting information about American history and the culture and scientific and technological developments of America The service is available to every one

On file in the Library are American official documents such as the full texts of speeches and statements by the President of the United States and other government officials government statistics and reports covering many U S governmental activities

American books on the following subjects are available philosophy, religion, social sciences, philo-

logy, pure sciences, applied science (including medicine, engineering, agriculture, communications, chemical technology, manufactures and building), architecture, painting, photography, music and entertainment, literature and history. The range of books on the social sciences is especially wide, including volumes on statistics, political science, economics, law, administration, military science, welfare and social institutions, education, commerce, customs and folklore.

Students planning to study in the United States are supplied with information about the various educational institutions, in the United States and opportunities offered by them to students from abroad

The Library also offers uptodate American reference books on agriculture and on technology, by specialists in their respective fields, such as food, chemistry, rubber, pulp and paper making, plastics, engineering in all its branches—civil, mechanical and electrical , radio, refrigeration and air conditioning, aviation, welding, etc

Vocational guidance pamphlets give a broad outline of the opportunities on studies involved in seventy three different occupations. A Dictionary of Occupational Titles and a book on Aptitudes and Aptitude Testing are available for reference

Women visitors will find abundant reading matter of especial interest to their sex There are such periodicals as Good Housekeeping, Ladies' Home Journal, Woman's Home Companion, Vogue and Harper's Bazaar, which explain and illustrate the latest ideas and conveniences in modern American homes

The Library includes the usual range of ready reference books such as dictionaries, atlases, directories, encyclopaedias, year books, almanacs, etc

Books and periodicals in the U S Information Service Library are available for use solely on a reference basis in the Reading Room during weekday business hours Service is free of charge, as are the admission to the Library, and the privilege of reading or consulting reference shelves

Replies to enquiries from outstations are sent out by post It is emphasized that the information available is especially pertinent to the United States

USIS Libraries are also situated in Bombay and Calcutta and are reported to have been of great service to the reading public in general and to journalists, students, scholars, and commercial and professional individuals

LADY TATA MEMORIAL AWARDS FOR 1946-47

THE Trustees of the Lady Tata Memorial Trust announced on 18th June 1946, the death anniversary of Lady Tata, awards of scholarships and grants for the year 1946-1947.

International awards for research in diseases of the blood with special reference to Leucaemias are made to Doctors Jorgen Bichel (Denmark), Pierre Cazal (France), Jal J Dubash (India), Pierre Dustin (Belgium), Peter A Gorer (South Africa), Maurice Guerin (France), Simon Iversen (Denmark), Werner Jacobson (England), Joseph Japa (Poland), Edith Paterson (England), Hall Schartum-Hansen (Norway), and Prof Edoardo Storti (Italy)

Indian scholarships of Rs 150/- per month each for one year for scientific investigations having a bearing on the alleviation of human suffering are awarded to Messrs L. D Sanghvi (Bombay), T A. Venkitasubramanian (Ernakulam), G Balasubramanyam (Bangalore), T K Wadhwani (Bangalore), Rabindra Kumar Basu (Calcutta), S Swaminathan (Bangalore), Jagannath Ganguly (Bangalore), Bhagchandra Jain (Bangalore) and Miss Anne Kumari Paul (Bombay)

ANNOUNCEMENTS

WE understand that Dr B. C Guha, Professor of Applied Chemistry at Calcutta University, now on loan to the Government of India as Chief Technical Adviser to the Department of Food, is proceeding to England to join the Preparatory Commission of the United Nations Educational Scientific and Cultural Organization as Counsellor for six months The work will be in the nature of defining the line and planning the future programme of work of the UNESCO and to make preparations for an international conference in winter Dr Guha is expected back in India by the end of this year

WE have been informed that the Rockefeller Foundation have renewed their grant of Rs. 15,000 to the National Institute of Sciences of India for disbursement among the societies and associations in support of scientific publications Last year the Foundation made a similar grant which was received by the various scientific publishing societies as a great relief. A sum of Rs 850/- was made over to the Indian Science News Association for which the Association remains grateful to the Council of the National Institute of Sciences of India and to the Rockefeller Foundation

SIR DORABJEE TATA Trust of Bombay has made a casual grant of Rs 1,50,000 to the College of Engineering & Technology, Jadavpur (Bengal) for the development of its department of Engineering Geology.

An independent two-years' course in Engineering Geology is to commence from January, 1947 in this college and graduates of Geology as well as Engineering of all the different universities in India will be admitted.

Mr K Sripada Rao, M Sc, F G S, Lecturer in Geology in the Central College, Bangalore (University of Mysore) is appointed Reader in Geology and Head of the Department of the newly created department of Geology at the Nagpur University, where teaching in Honours Geology is to commence from July, 1946

Mr Rao is a reputed paleontologist and has contributed a number of papers on the "Fossil algae of the Rajahmundry limestones and its bearing on the Age of the Deccan Traps" (*Pal: Ind* XXIX, No 2).

ERRATA

On Page 653, of the June, 1946 issue in line 13, (column 2) *read* 'target' *for* 'largest'.

On Page 1 line 1 of this issue *read* Sanitarians *for* Sanatarians

SCIENCE IN INDUSTRY

STRATEGIC MINERALS FOR U. S A.

In an article entitled "Strategic Mineral Supplies" published in the last January number of the *Scientific Monthly*, Prof Adolph Knopf, Sterling Professor of Geology, Yale University, describes the services rendered by official and non-official geologists in obtaining from domestic sources the supplies of strategic minerals Their first task was to determine the availability of raw materials without which no weapons of war can be made For an intelligent national mineral policy and procurement plan authoritative information on this point is a fundamental necessity The estimates were of three categories measured ore, indicated ore, and ore inferred from geologic evidence The second task of the geologists was geologic supervision of mining In this the U S Geological Survey supplied resident consulting geologists either from its own staff or *from the Universities* Their principal work was to discover more ore and to locate dislocated segments of ore bodies The third job of the geologists was to find more ore in the producing districts by studying the special features of ore occurrences in particular districts. The fourth duty which is the most difficult of all was to find new districts

The minerals required in war effort were classified in three categories strategic minerals which are not known to exist in the U S A, critical minerals which could be produced by price stipulation, and essential minerals of which there is an ample supply in America Nickel and tin are examples of strategic minerals which are not found in the United States Nine-tenths of the world's known supply of nickel is localized at Sudbury in the Ontario Province of Canada, and much of the rest in New Caledonia

Magnesium developed faster than any other metal during the war owing to its demand in air plane construction and incendiary bombs The chief sources of magnesium are sea water and dolomite A complete inventory of the dolomite resources was made after accurate sampling and tonnage measurements Every one knows that dolomite is an abundant rock but when extreme purity, accessibility, and availability of a large supply of electric power are considered only a few deposits become workable Aluminium is another important war metal The American domestic source is in the Arkansas and when submarine sinking stopped the supply from Surinam in South America (Dutch Guiana), the production from Arkansas stepped up from 400,000 tons to 6,000,000 tons a year To conserve the domestic reserves, a vigorous campaign of exploration for more ore was made and foreign ore was again imported as soon as the danger of submarine sinking ended Substitute materials were also sought and the possibilities of extraction of aluminium from high-alumina clays and feldspar rocks were explored

Vanadium is another important war metal The chief source was Peru but under the stress of war an immensely large deposit of vanadium ore was discovered in Idaho Among other strategic and critical minerals mention may be made of mica, beryl, tantalite and columbite which occur in pegmatite veins It may be noted that the main source of mica is India whence it was flown into America for some time In order to stimulate home production Government paid a bonus of $4.40 per pound *i e.*, sold it at $1 60 a pound after purchasing at $6.00 a pound but still scarcely any new deposit of high grade was found. The rare element tantalum found a remarkable development in the use of tantalum wire in sewing nerves besides its use in radio grids and other purposes. Columbium is now

in demand for its use in jet-propelled planes as the only metal that will stand the high temperatures. Tantalum is obtained from Western Australia and Brazil.

Beryllium obtained from the mineral beryl is lighter than aluminium and confers remarkable properties when alloyed with copper

Lastly but not the least is petroleum Marshal Foch remarked, "In war a drop of gasolene is worth a drop of blood" The American output reached its peak in 1944 of 1700 million barrels A search was made for new fields and the year 1944 ended with a gain of 500 million barrels to the proved reserves of 20½ billion barrels. The problem of finding fresh fields is engaging the attention of geologists in order to maintain efficient rate of production from the fields now being worked Additional reserves may be found by exploring in new areas which are few, by tapping deeper strata, and formations below unconformities

In conclusion Prof Knopf makes important remarks on the limitations of geophysical prospecting and its dependence on geologic data Geophysical methods 'do not reveal directly the presence or precise nature of the deposit' Geophysical results may be interpreted in several ways and a correct interpretation depends upon accurate geological knowledge of the area For this purpose a geological atlas of the whole of the United States comprising more than 13,000 maps on a scale of one or two miles to the inch is needed

IMMERSION SUIT

PROTECTION of men from cold water on the sea was a serious problem for all fighting nations England and U S A generally used very tight woven fabrics with a sufficient water repellent finish or coating, or leather clothing similarly treated in order to keep the water away from the skin of the men in water

But none of these was comfortable in-as-much as physical movement was more or less restricted in every case Neither was permeable to air when dry, so none helped the dissipation of the body heat The German scientists solved this problem in a novel way. They made a three-layer suit with rayon—a filament acetate poplin was placed outside, next came an acetate plush with pile projecting towards the outside, that is, away from the body and lastly a viscose filament tightly woven fabric which was in contact with the body The three were sewn together. A foam powder (about 4 4 lbs per suit) was deposited on the pile of plush and kept in position by careful sewing. Now, the acetate rayon, having a low hygroscopicity, absorbed only a small amount of water The water that penetrated this outermost layer, came in contact with the foam powder on the plush and sufficient foam was produced immediately The viscose rayon in contact with body swelled quickly by absorbing water The openings are largely closed up and as a consequence, very little water could penetrate this layer to reach the body The little that came in contact with the body soon attained the body temperature The layer of gas which is a non-conductor of heat, largely protected the man from cold from outside. The stablized foam, generated under pressure, prevented in inflow of cold sea water when a man fell into the sea An immersion suit of this kind consisted of a trouser, jacket, gloves and shoes Apparently, it was an ordinary suit, quite flexible and comfortable The collar was of foam rubber, which was kept open normally but could be tightly closed at will by simply pulling a cord A life belt was used round the neck in order to help the head to remain above water Provided with such a suit, a man could easily remain even in ice cold water for 24 hours Both the German Navy and Air Force were provided with these immersion suits

The foam was produced by rather a simple device—by the interaction of sodium bicarbonate and citric acid in molecular proportion The acid is readily soluble in sea water and, what is more, does not irritate the skin Being tribasic, it generates relatively a large proportion of carbon dioxide The necessary foam medium was Mersolate (type H30) which was found to be the best The composition of the I G foam powder was 24 4 per cent mersolate (low in salt content), 41 40 per cent sodium bicarbonate and 34 14 per cent citric acid One ton of such powder would be sufficient for 500 immersion suits.

P B S

CHEMICAL DEFOLIATION AND IMPROVED HARVESTING

A RECENT publication of the American Cyanamide Corporation contains some interesting results of investigation on the process of defoliation with chemical reagents like calcium cyanamide. The advantage of chemical defoliation consists in an early and more uniform maturing of the crops Besides the process often leads to increased yield, better crop, and considerable saving in time and labour So far cotton, soya beans, and outdoor tomato crops have very satisfactorily responded to the process.

In the case of cotton, the fields are dusted with calcium cyanamide shortly before harvesting The compound, in the presence of dew, kills the leaves which are cast off in course of a few days. The

cotton bolls thus exposed ripen rapidly and uniformly It is to be noted that the stem and the roots of the plant are not affected as a result of cyanamide dusting

Some of the distinct advantages derived from chemical defoliation are (1) the possibility of harvesting the crop by one single picking instead of the usual two or three pickings at intervals, (2) greater daily harvesting speed (reported to be twice as much); (3) elimination of losses due to putrefaction, particularly during wet seasons, which formerly amounted to as much as 50 per cent, this is made possible by the free access of air and sunshine to the lower bolls of the plant and also by minimizing the destructive activity of worms which thrive on the leaves, and (4) wide adoption of machine harvesting with consequent improvement in yield

Soya beans, particularly the heavy cropping varieties maturing late in the autumn, have responded well to chemical defoliation. On account of late harvesting of these crops, subsequent sowing of winter grains are hardly possible Defoliation, carried out at any time after the seeds lose their green colour, causes rapid loss of moisture without reduction of yield or quality, the seeds becoming sufficiently dry for harvesting at the early crop premium prices It also leaves sufficient margin for sowing winter grain.

Outdoor tomato crops are also reported to have been benefitted considerably Defoliation enables the later trusses to ripen before the early autumn frosts cause loss of good green fruit

HIGH-INTENSITY X-RAY TUBE

The development of a new high-intensity x-ray tube by the Machlett Laboratories, Springdale, Connecticut, has been announced in the *Review of Scientific Instruments* The high dosage rate, reported to be in excess of 2,000,000 Roentgens per minute, make this instrument a new tool for investigating the effects of x-radiation in producing modifications in matter, for researches in photo-chemistry and in sterilization of food products

A specially designed water-cooled anode has made possible a high anode current The absorption of the x-ray energy at the window has been considerably minimized by using thin sheet-beryllium. Lastly, the location of the focal spot of the tube in close proximity of the window has further contributed to the available high intensity of the x-radiation But the whole success of the design is reported to rest on the ability to produce the thin sheet-beryllium in vacuum-tight form and use it as a window to be placed very close to the focal spot without overheating or being electrically charged

The tubes so far designed for commercial production provide a 40-degree cone of radiation and, therefore, guarantees a sufficient coverage Design of tubes making available 180-degree cone of radiation is now under investigation The researches of the Laboratory have already operated, on an experimental scale, an x-ray tube, fitted with a hemispherical window and employing an entirely different principle of processing, in which the entire 180-degree solid angle of radiation is available for use

FUTURE OF DAIRYING IN INDIA

T M PAUL, C P ANANTAKRISHNAN and M C RANGASWAMY,
IMPERIAL DAIRY RESEARCH INSTITUTE, BANGALORE

THE average milk consumption in India was less than 8 oz. per head per day even in normal times. This itself was just below one third of the normal minimum nutritional requirements After the war broke out, the floating population in the country has increased, particularly in the cities and the demand for milk has increased at least twofold On the production side, it is obvious that it has gone down due to various reasons Cows are being slaughtered in ever increasing numbers, so much so, that, the central as well as the provincial governments got alarmed and had to take legislative measures to check this Again, due to the very high demand for meat and hides the price of cattle have gone up very much and an ordinary villager cannot afford to purchase a cow or a buffalo In addition to these the question of the supply of fodder and concentrates has become very costly and more often they are not available at all This, therefore, compels the ryots to sell the cow or the buffalo to the butcher which only aggravates the problem of milk supply Thus it is tending to be a vicious cycle Poverty of the farmers compels them to sell their cows which in its turn makes them still more poor The government has realized the significance of this problem and has in view a thorough re-organization of the dairy industry in the country But it is necessary that the dairy-man also should know the line of action he has to adopt in the post-war reconstruction of his trade in co-operation with the government

India's estimated milk production is about 23 million tons, which works out to 7 oz of milk per head per day Of the total production, the consumption as liquid milk is only about 31 per cent , which reduces the per capita consumption of fluid milk to 2 25 oz Naturally persons with higher income consume much more milk than 2 25 oz with the result that a large proportion of India's population has to subsist practically without milk If the daily requirement of protein and fat of an average Indian are about 65 and 56 gm. respectively, a fourth of the protein and two-fifths of the fat required could be met by milk if one consumes about 20 oz of milk To meet with this requirement for the 400 millions of people, about 80 million tons of fluid milk are required. This necessitates an increase in the total production at least four-fold.

The average lactational yield of the present dairy animals in India is about 650 lbs and unless this is brought up to at least 2500 lbs as is generally obtained in many of the recognized dairy farms in India, the only other alternative is to increase the cattle population three-folds, which India can neither maintain, nor is it feasible to do so Therefore, the best plan of achieving this increased milk production is by increasing the milk yield of the existing animals by improved breeding, feeding, management and disease control.

BREEDING

India is next to none in the number of cattle (215 millions) that she possesses But they are mostly of a non-descript type with possibly the lowest milk yield in the world Therefore, the indigenous breeds of cattle have to be improved by gradually grading them up by pure breeding and selection First this has to be taken up in certain selected localities and then gradually spread to other places A good number of bulls may be required in this connection and they have to be supplied from the government farms The existing government farms have to be expanded and new farms have to be started

Therefore, the first concern of the government in the post-war reconstruction should be the replenishment of India's livestock with high pedigree animals suited to the varying needs of the country Improvement in the breeding of dairy cattle by the breeding of bulls which will transmit high milk producing capacity with a high degree of certainty and the grading up of the herd by the use of such bulls is bound to give outstanding results By using proven bulls exclusively for 2 generations a non-descript herd could be made a herd of reasonably good production Another way of meeting this demand is the adoption of artificial insemination which is a regular practice followed in Soviet Russia and United States of America with staggering results in the end This is possibly the only way to build huge number of dairy herds with the least number of pedigree bulls in the shortest period and especially when the methods of preserving the semen for a number of days have been developed and are being improved upon every day The only drawback is that the individual owners do not maintain big herds in India, but the required number of cows could be secured through co-operation of cow owners. All non-descript bulls in the area have to be castrated as also the male calves from them. Systematic record of the service of the bulls and the milk yield of cows have to be maintained, to pickout animals

with outstanding merits Milking cows three times a day generally result in stimulating the secretion of milk, especially when adopted from the first lactation onwards This also deserves special attention in the direction of increased milk production

Systematic pure breeding work done during a period of 10 years will certainly improve the quality of Indian cows Cross breeding unless under special conditions shall not be encouraged generally in view of the susceptibility of such animals to various diseases and the loss of constitution and milk in future generations For each particular area the most suitable breed of animal should be selected and that alone should be bred pure in that locality Ryots may be encouraged to maintain registered pedigree bulls by giving them an attractive annual grant. Cattle shows and fairs may be arranged in each district more frequently so as to give proper encouragement and publicity to the keeping of good bulls and cows Good breeding methods alone are not enough for reaching the 80 million tons target.

Feeding

Cattle feed of the right kind is very important from the point of view of milk production At present our animals are underfed for the major part of the year Fodder is very seldom cultivated, but the straw from crops remains the main source of fodder When crop production is increased, straw production also will increase naturally Along side, fodder cultivation also has to be increased which could be preserved as silage or as hay for meeting the demands of summer months Grazing grounds are being reduced year by year and brought under cultivation This tendency is only likely to remain so, as the country is not self-sufficient with regard to human food Therefore, if at all production of grass could be increased, it is only be adopting more scientific methods like rotational grazing Perennial grasses like guinea, napier etc , have also not made any appeal to the Indian dairyman By suitable propaganda these may be popularized in the Indian villages Suitable fodder crops and grasses have to be selected for each tract after a study of the climatic and soil conditions of each locality

The importance of concentrates for milk production is well known India produces 8 million tons of oil seeds and the total amount of cake available is only 4 million tons Even if the entire resources of cakes is utilized as cattle feed, a supply of 0.98 million ton of total protein could be expected This is far less than the actual requirements of our cattle and one way of meeting the protein requirements would be to cultivate high protein fodders like alfalfa, berseem and other leguminous crops besides oilseeds Considerable amounts of the oilseeds are being exported as also certain amount of the cakes produced in the country Oil cakes are used as manure. This export trade should be completely stopped and other fertilizers should be encouraged. It may not be in the interests of the country to bring more land under the oil seed cultivation—but it would be very advisable to increase the production per acre by proper manuring and more scientific cultivation

Thus all the existing sources of cattle-feed should be increased to the fullest maximum possible At the same time it may not be difficult to find out some alternative sources of fodder supply and to make the present sources more useful At present, large amounts of sugarcane tops are being produced as also large amounts of molasses Prospects of making silage from the sugarcane tops and producing yeast or other cattle feeds from molasses are quite bright Thus by increasing the cattle feed resources of country alone—an increase in the milk-production by 25 per cent is quite possible

The areas which border the Rajputana desert happen to possess the best breeds of cattle in India The soil is rich and crop and fodder grasses grow luxuriously in normal times The conservation of roughage in times of scarcity or tapping new sources of cheap fodder supply during famines is a serious problem to be tackled here When there is no rain, there comes a complete failure of crops and a majority of cattle either die of starvation or are disposed of at low prices Most of the animals develop depraved appetite and all that comes before them are eaten up, resulting in low milk yield, fewer conception and dropping of premature calves Agricultural wastes like husks from groundnut, paddy, bajra and corn hearts reed by suitable alkali treatment or otherwise is likely to yield a type of roughage suitable to these areas and deserves special attention.

Management

In India, cow is traditionally worshipped as the ultimate source of all human well being—but in spite of that the treatment meted out to her is very pitiable The housing of the cows is very poor and hence the animal is exposed to the extremes of climate. All the time the cow is on a starvation diet—whatever milk comes from the udder is milked —and milk is not at all produced in India as a result of the care and the management of the cattle There is no provision to give even enough water to the cows in summer, let alone grooming or washing the cow.

For the production of hygienic milk every village should be provided with a clean milking shed. Even the housing of the cows should be improved. This,

as well as the grooming etc., has to be encouraged by suitable propaganda, care and management of the dry cows and the young stock is still worse particularly in the cities The long dry period common among the Indian breeds is one reason for the disregard of dry cows. Difficulties of fodder is another one. But with some care and adequate propaganda this could be easily solved. The disregard for young stock have far reaching consequences on the future of the dairy industry. The S. P. C. A or any other body should be induced to salvage all dry cows and calves which are of any use. This is particularly necessary in all the cities Proper care and management of the cattle will greatly improve the condition and qualities of the animals gradually.

Disease Control

Just as in the case of the human population, cattle are also susceptible to periodic epidemics in India, resulting in a great loss to the country The most important scourge of these is rinderpest, while haemorrhagic septicoemia, anthrax, black quarter, tuberculosis, John's disease, foot and mouth, contagious abortion etc., are also quite common Apart from the loss of life involved, some of these diseases *viz.*, rinderpest occur at such critical times when the livestock owner needs the animals most for work on the fields, thus entailing an additional loss The use of the rinderpest vaccine has yet to be brought to the knowledge of the villager Similarly other results achieved in research institutions have not been exploited fully

Another important aspect of disease control is to make all the advances in veterinary medicine available to the agricultural population of India who are the custodians of the Indian livestock The present day veterinary service is quite inadequate in this respect. More staff, more dispensaries and hospitals and more funds are required. Every village should have one dispensary under the charge of a qualified veterinary man. A well equipped hospital is necessary at every district head quarters. Again the veterinary service has to be mechanised so that all the facilities at the command of the veterinary doctor are made available to the distant villager in the shortest possible time Strict control should be exercised over the movement of cattle during times of epidemics by suitable legislation which is lacking at the present time. Veterinary education should be encouraged by making the veterinary service more remunerative than at present. Manufacture of sera and vaccines have to be augmented further and the scruples of the people against the use of them have to be removed by suitable propaganda.

6

Cattle Insurance

The hand-to-mouth existence of the livestock owner in India does not allow him to save anything from his daily earnings Therefore when the cow or buffalo dies, he does not have any funds to replace them. This compels him to go to the money lender who charges exorbitant rates of interest Sometimes the poor dairy-man takes an advance from some of his old customers and purchases the cow or buffalo in which case he has to sell milk to the creditor at a low price Either way the dairyman is a loser which could be avoided by starting a system of cattle insurance on a co-operative basis This may be made even compulsory in the case of cows belonging to milk vendors A system of insurance like this will compel the dairyman to save gradually and when his cow goes dry or dies, he has no difficulty in buying a fresh one Cattle insurance could be extended to draught bullocks and stud-bulls also with advantage.

Marketing

In India, marketing of milk is as difficult as the production of milk if not more The unhygienic ways of production, unclean handling of milk and the hot climate, all contribute towards shortening the life of milk The milk producers in their anxiety to adulterate milk, add any water they come across to the milk, making it even unsafe for human consumption. This, as well as other forms of adulteration have to be stopped by strictly enforcing the food laws which are already in existence

Of late milk supplies to the cities has become a tough problem The available quality of milk in cities has probably gone down ; in any case it has not gone up but the demand for milk has increased very much Consequently the price has increased and very often milk is not available for any price. This is having far reaching effects upon national health. To relieve this difficult situation, the corporations or the Governments themselves will have to start dairies outside the cities. Keeping cattle within municipal limits should be discouraged. By suitable and quick means of transport the milk produced in dairies situated outside the cities could be brought to the cities and the distribution may be carried out through some organisation in the city The actual cost of production may be collected from the customers so much so that nobody is a loser. By starting large dairies with good cattle, and supplying them fodder and concentrates at controlled rates, it is quite possible to produce good quality milk at cheap rate. Any surplus milk produced could be converted into condensed milk or milk powder when milk production is centralized

like this Co-operative societies may ensure good quality milk to the consumer as well as a fair return to the dairyman. All milk business should be carried out only through such a co-operative body

A re-organisation of the dairy industry on the lines suggested will certainly improve the lot of the dairy cows and buffaloes, the dairyman and the health and well being of the population in general Breeding of more economic breeds of cows, buffaloes, goats and sheep in various centres with a view to spread them in the country, feeding them the most suitable fodder and concentrates in adequate amounts which will ensure maximum production of milk, proper care and management of the herd, a well developed veterinary service to combat all cattle diseases, a co-operative cattle insurance system and proper organizations sponsored by government or public bodies for the marketing of milk products will go a great way to improve the position of dairying in India in the years to come.

MEDICINE AND PUBLIC HEALTH

MEDICAL RESEARCH IN INDIA

THE annual report of the Scientific Advisory Board for the year 1945 issued by the Governing Body of the Indian Research Fund Association states that 47 independent schemes of research work have been carried on in connection with those diseases (*e g.*, cholera, malaria, leprosy, plague, malnutrition, etc.) which are responsible for high rates of mortality and sickness in India.

Cholera Active research work on the cholera vibrio and the epidemiology and treatment of cholera, has been resumed A special statistical enquiry to assess the protective value of cholera inoculation is in progress in Madras Presidency. The Haffkine Institute, Bombay, has evolved a new and simpler method of manufacturing cholera vaccine by growing the vibrios in a liquid medium containing casein hydrolysates Preliminary tests carried out on mice indicate that this vaccine has a better protective value than the vaccine prepared by the old method Confirmatory tests to establish this claim are being carried out at other laboratories Experimental trials with sulphaguanidine in the treatment of cholera have been carried out at the School of Tropical Medicine with encouraging results. Further trials on a larger scale have been arranged A sum of Rs. 87,000 is budgeted for the investigations in cholera in 1946

Malaria. A series of field experiments including spraying from the air were carried out by the staff of the Malaria Institute of India Both oily solutions and watery emulsions of D D.T. were used. D.D.T. is extremely effective against *Anopheles minimus*, the chief malaria carrier of foot hills of Bengal, Assam and Burma. Experimental trials with the new synthetic antimalarial drug, paludrine (M 4888) carried out on monkeys infected with malaria, show it to be superior to mepacrine in certain respects A new enquiry on Mammalian Malaria has been started at Kasauli in collaboration with the sub-committee on Tropical Diseases of the Royal Society, London The object of this enquiry is to determine if the malarial parasites of mammals also have a similar phase of development outside the red cells of the blood, as is the case with the strain of parasites responsible for malaria in birds. The discovery of such a phase, it is anticipated, is likely to provide the much needed clue which might be of immense help in evolving really effective treatment for the relapses of malaria which unfortunately are so common and are difficult to control. A sum of Rs 1,76,452 (including a grant of Rs. 56,000 for research in Mammalian Malaria) is budgeted for malarial investigations in 1946

Leprosy Investigations carried out in Madras by the staff of the Lady Willingdon Leprosy Sanatorium, Chingleput, have revealed some facts which help to explain why certain villages situated in close proximity to one another have a much higher incidence of the disease than others. It is pointed out that ordinarily the disease is not contracted through casual contact alone and a more intimate relationship, *e.g.*, marriage between infected and uninfected inhabitants of two different villages is essential for the spread of infection Segregation of cases of leprosy at night where enforced, has resulted in a general reduction in the incidence of this disease in the village concerned.

Plague · D.D.T. and 666 have been successfully used for killing rat fleas and checking the spread of plague. Further improvements have been effected in the preparation of plague vaccine at the Haffkine

Institute, Bombay. The staff of the King Institute, Guindy, have carried out experiments to elicit the comparative value of the ordinary calf lymph and smallpox vaccine prepared from chick embryos A small quantity of Influenza Vaccine "A type" has been prepared for experimental trial.

Nutrition. Work carried out in the Nutrition Research Laboratories at Coonoor, included the determination of the theamin and nicotinic acid content of different samples of yeast, yeast extracts, wheat, rice, vitamin tablets, etc Experiments are in progress on the loss in vitamin A content of ghee when stored under different conditions Experimental investigations on the nutritional properties of the cocoanut kernel were commenced

The work on infantile beriberi in Coconada has proceeded and a report is under preparation The curative effects of pure vitamin B, on infants suffering from beriberi has been abundantly confirmed The report of the soya bean sub-committee was completed and published A sum of Rs 1,85,000 is recommended for researches on nutrition for the year 1946 of which a sum of Rs. 1,21,000 is to be spent at Coonoor.

Medical Mycology Determination of the species of ringworm fungus common in India was continued at the School of Tropical Medicine For a person susceptible to ringworm and to prevent a re-infection, a 4 per cent Glacial Acetic acid solution in 25 per cent alcohol is required Culture of the fungus *Malassezia ovalis* and preparation of an antigen in cases of seborrhoeic dermatitis were continued A grant of Rs. 13,000 is recommended for the continuation of the investigation

Pharmacology. The Drug Research Laboratory, Jammu, Kashmir, continued its work on indigenous plants of pharmacological importance Experiments were also carried out in the cultivation of pyrethrum flowers at different altitudes and the preparation of extracts with different solvents Investigation on the percentage yield of the oil and their physical properties in a number of essential oil bearing plants growing wild in Kashmir was carried out. A sum of Rs. 6,000 only is budgeted for indigenous drugs enquiry in 1946.

Penicillin: Methods for the manufacture of penicillin and other problems connected with it were carried out at the Haffkine Institute, Bombay and the investigation is to continue with a grant of Rs. 17,000 for 1946.

The Advisory Board recommended to the Governing Body an allotment of Rs 10,64,000 for expenses under various heads for the year 1946 Of this a sum of Rs. 6,60,000 is budgeted for 48 independent enquiries and investigations on the various diseases, nutrition, etc., to be conducted during the year.

SOYA BEAN

The soya bean (*Glycine hispida* Maxim), a native of the Far East, has been cultivated in China, Manchuria and Japan from very early times and is today an important article of diet in these countries. In the U S.A, it has been extensively grown as an industrial crop. It has been introduced into India but is cultivated only on a limited scale

Considerable discussion has taken place on the subject of soya bean and its potentialities as a food crop in India. The bean contains some 40 per cent of protein and nearly 20 per cent of fat and is a fair source of some of the B vitamins, calcium, phosphorus and iron Widespread cultivation and popularization of soya bean has been suggested because of its high content of protein, fat, etc, that would serve as an excellent supplement to poor cereal diets, thereby solving the problem of nutrition in India.

The Nutrition Advisory Committee of the Indian Research Fund Association appointed a sub-committee in 1941 consisting of Dr W. R. Aykroyd, Dr U. P Basu, Prof B C. Guha, Dr V. N. Patwardhan and Dr K. C K. E Raja, to study the nutritive value of soya bean in comparison with that of various pulses now commonly consumed in India.

The report of this sub-committee, based on the experiments carried out at Dacca, Bombay, Lahore and Coonoor, states that soya bean has no special advantage over common Indian pulses as a supplement to typical Indian diets based on cereals but *supplied adequate in quantity* and as such the sub-committee is not in a position to advocate *immediately* the encouragement of the production of soya bean on a wide scale in India for use as a substitute for Indian pulses.

Soya bean milk even when supplemented is not equivalent to cow's milk in nutritive value and a successful feeding of infants with a mixture of soya bean flour and dried whole milk has been reported.

Growth experiments on rats with soya bean milk carried out at Dacca show that the average increase in body weight of the rats receiving a supplement of soya bean milk was slightly lower than that of cow's milk, but more than double that on the rice diet alone with no supplement. The report adds that although soya bean contains more of fat, minerals, vitamins and available proteins than other pulses, it has for some unknown reasons, not proved itself superior to other pulses.

A school feeding experiment carried out in Lahore shows that boys receiving soya bean showe

no advantage in respect of increase in weight, over those receiving black gram

FAMINE FOOD

PROTEIN Hydrolysate containing mainly amino acids and peptides is now being extensively used with satisfactory results in cases of starvation. It is also useful in various pathological disorders for maintaining nitrogen balance and causing regeneration of serum proteins. The preparation is often adjuvated with glucose, but this may react with tryptophan present in the protein hydrolysate with the formation of melanin like compounds, and thereby, affect the concentration of the above indispensible amino acid in solution As a matter of fact it has been noted in the Bengal Immunity Research Laboratory that a hydrolysate containing glucose loses its tryptophan content on storage, whereas the same hydrolysate stored without glucose retains its tryptophan content for months together. It would, accordingly, be of considerable interest to find out the changes in the nutritive value of protein hydrolysate made with glucose on storage, so that this useful preparation may always be safely used in emergency

U. P. B

SOME SCIENTIFIC AND PRACTICAL ASPECTS OF RICE PROCESSING

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SINCE the discovery of the curative and protective values of the water-soluble constituents of rice bran and polishings a number of attempts have been made to legislate or otherwise bring into general use the different food factors that are ordinarily lost during milling. Among the various proposals that have been made, special mention has been made of (*i*) use of hand-pounded or under-milled rice, (*ii*) use of par-boiled rice and (*iii*) adoption of special rice conversion methods More recently, methods of enriching rice with added vitamins have also been proposed.

Following the convincing demonstration of Fraser and Stanton, a number of sessions of the Far Eastern Association of Tropical Medicine, the League of Nations (Inter-Government Conference of Far Eastern Countries on Rural Hygiene) and other bodies have pressed for State legislation for the use of undermilled rice. Excepting in certain restricted areas, these proposals have not, however, met with any good response because of the practical difficulties attendant on the storage and handling of undermilled rice. Spoilage through rancidity and insect attack has greatly discouraged the use of undermilled rice Moreover, the undermilled rice loses a considerable part of the water-soluble constituents during the preliminary washing of the grain and subsequent drainage of the gruel. It is now generally recognised that even enforced distribution of undermilled rice will not solve the main problem.

It has been argued by some investigators that if clean methods of milling are followed and if polishing powders are eliminated, the consumers could be induced to take unwashed, undermilled rice Polishing powders are not much used at the present time, and, even if all dirt is eliminated during milling, washing will still be resorted to because the majority of consumers do not really like the floating masses of the bran and the adhering polishings. Apart from affecting the appearance and taste of cooked rice, whole bran is indigestible and hence not popular The polishings add to the gruel content which, if not removed, causes the grains to stick together The stuck masses are unattractive and experience has shown that they are also less digestible than when the grains are washed free from the adhering gruel.

DIGESTIBILITY AN IMPORTANT FACTOR IN ASSESSING QUALITY IN RICE

In the popular evaluation of food stuffs, digestibility is a very important factor to be reckoned with. The general concept of digestibility is largely based on experience, but it has also a sound scientific background. Rice cooked in such a way that each grain is distinct from the others is always more easily digestible than the same rice cooked to a thick or pasty mass. In the former case, the cooked grains present a considerably larger surface than in the latter, so that the digestive juices have greater scope for penetration and action. This can be easily demonstrated by *in vitro* trials using plant, animal or microbial amylases. The same reason underlies the popularity of rice which has been stored for

some time as against rice which is fresh from harvest. The former cooks in such a way that the individual grains stand apart · the latter usually cooks to a pasty mass.

A fairly large section of rice eaters consider ease of digestibility to be an important factor determining the quality of rice The working classes—particularly those working in the fields and factories—prefer the slower digesting varieties, as also parboiled rice, which is slow to digest. A further discussion of this aspect will be taken up in a later section.

Another important factor that determines quality in rice and which, in some form or other, is greatly appreciated by all consumers, is the property of swelling. It is this property which accounts for the feeling of satisfaction that comes from a well-filled stomach. A good section of consumers like rice that swells up to the maximum extent followed by quick digestion so that the heaviness does not persist

Parboiled Rice—the Creation of a Genius

Parboiling of rice has been known and practised in India almost from very early times The origin of the method is somewhat obscure but the person who first introduced it must have been something of a genius because the apparently simple method embraces certain fundamental principles which science has discovered only in recent years Parboiling is now being adopted throughout the country, though the use of parboiled rice has been largely confined to certain sections of people

Parboiled rice is frequently mentioned in literature and a certain amount of scientific work has also been done on the actual conditions of parboiling Parboiled rice is not however, much used outside India, Burma, Malaya and other areas where Indians have actually settled. It is not unnatural therefore that in the other parts of the World—especially in Europe and America—the principles and practice of parboiling are not so well-known as they would otherwise be.

Over most parts of India, parboiling is still being done according to traditional methods handed down from one generation to another. The details do, of course, vary from place to place, but the fundamental principles remain the same. The paddy is steeped in water to facilitate thorough soaking. Heating helps the penetration of water and the attendant changes. Steaming of the steeped grain also produces similar effects in shorter time. The steeped grains are then dried, generally in the sun and then hulled and milled in the usual way. Parboiling is usually done during dry hot weather; so, mechanical drying is not generally necessary,

Changes during Parboiling of Rice

During parboiling, the following general changes are known to take place The water-soluble constituents of the bran and the husk are acted on and extracted, and while a certain part comes out into the steep water, quite a considerable part is actually absorbed by the endosperm of the grain During heating or steaming, the grain swells and softens to some extent and the water-soluble matter penetrates to a certain depth Depending on the extent of heating, the starch of the endosperm gets gelatinized and forms a glassy coat of variable depth There is also some coagulation of protein from the bran layer The colouring matter from the husk and the bran also penetrates to depth The steeped and heated paddy develops a smell which is rather characteristic This smell is appreciated by those who are accustomed to parboiled rice

Merits of Parboiled Rice

It has been known for a long time that parboiling improves the milling and keeping qualities of rice In fact, the low grade and coarser varieties of rice which are apt to break during milling are generally parboiled prior to milling The gelatinized starch forms a good protective coat and preserves the grain surface from turning rancid , it also discourages insect growth The vitamins and dissolved minerals having penetrated to some depth, there is less loss during milling than would otherwise be the case

Defects in Parboiling as now Practised

Parboiled rice has also its demerits which render it unpopular with a certain section of the rice-eating population Firstly, it is usually unattractive in appearance It can of course be polished to yield a white grain, but this will involve considerable wastage of good food material the vitamins will also be mostly lost in the process The normal smell of parboiled rice is itself disagreeable to certain sections of rice consumers This is rendered worse by indifferent steeping, use of dirty water, allowing the water to stagnate for long periods to undergo fermentation and so forth Quite a considerable amount of commercial parboiling is done carelessly with the result that the bad odours from the steep water could be smelt for some miles around. Parboiled rice is slow to cook, the time required depending on the extent of gelatinization of starch. The cooked rice is somewhat difficult to digest On cooling, the cooked rice tends to soften and turn hard. This again renders it unpopular with a good section of

users who would like the rice to remain soft even after standing for some time.

Sustaining Power

Strangely enough, some of the above qualities render parboiled rice very popular, especially with the working classes, in some parts of the country. They like the smell and the taste of the product. To them, the slow digestibility is a qualification as they require something to sustain them during the hours of hard work. Stiffening on cooling is also an advantage to them as the rice then keeps well. Most of the working class people cook only once a day. In some parts of the country, parboiled rice is steeped under water and used the next day as cold rice. Used in that manner, the parboiled rice remains fairly soft: it also develops a pleasant smell associated with lactic fermentation.

In the case of food products, it is very difficult to lay down anything as an absolute standard. Tastes vary considerably; habits and traditions also play a large part. Persons accustomed to parboiled rice continue to like it. Such people even get ill if they have to change over to the use of raw rice, the usual complaint being a form of diarrhoea. Those accustomed to raw rice find it difficult to get used to parboiled rice, the frequent complaint being one of heaviness and indigestion. In either case, it is only a question of time, the system getting steadily acclimatized to the change of food.

Parboiling—the Basis of Scientific Processing

The rather detailed discussion of the qualities of parboiled rice is justified because many of the properties are not well known to scientific workers, especially outside India. Furthermore, as already mentioned, the principle of parboiling is an important basis for rice processing and many of the developments that have taken place in recent years are largely based on the same fundamental principle. As will be seen in the subsequent discussion, *parboiling, scientifically carried out, holds out considerable possibilities for the future.*

Rice Conversion Methods

During recent years, several attempts have been made to improve on and to mechanize the parboiling process. Perhaps the best known among these is the Huzenlaub method also known as the Rice Conversion process.

It is not the object of this contribution to discuss whether the above or any other such method really constitutes a fundamental invention. This is a point of law which may, one day, have to be adjudicated by competent legal authorities. There is no doubt that the principles actually applied are the same as those of parboiling. Kik and Williams in their recent *Bulletin of the National Research Council* (*No. 112, June 1945*) have drawn pointed attention to this feature. At the same time, mechanization is definitely an improvement and facilitates large-scale processing.

In principle, the methods employed for rice conversion would correspond to that used for impregnation of electrical transformers. There is initial evacuation to remove intra-cellular air followed by the application of heat under pressure to facilitate the gelatinization of the starch in the entire grain. The operations are no doubt quick and thorough. The risk of fermentation consequent on prolonged steeping is eliminated.

The patentees of the different conversion processes have claimed that rice prepared according to their methods is nutritively quite superior and possesses at the same time, several advantages over raw rice. A critical examination of their claims as compared with those of raw and parboiled rice would reveal the following.

Parboiling *vs* Rice Conversion

From the point of view of the chemical composition and many of the properties, parboiled and converted rices resemble each other rather closely. In regard to the retention of essential food factors, converted rice appears to be superior to parboiled rice, but systematic trials with the same varieties should be carried out to determine whether the superiority is statistically significant.

Speaking generally, there are at present two main classes of rice consumers, one preferring raw rice and the other parboiled rice. If any method of rice conversion is introduced, it will appeal largely to those accustomed to parboiled rice. Converted rice will have the same characteristics as parboiled rice—perhaps in a more pronounced manner—and persons who prefer raw rice will not readily take to it.

It is claimed that rice conversion by a mechanical method would be cheaper than parboiling. Any mechanical operation conducted on a sufficiently large scale would reduce cost by eliminating human labour, reducing time of operation and so forth. The economic aspects would, however, require careful study under actual Indian conditions. Among the factors affecting the cost, one should also take into account the extra quantity of fuel required for

TABLE

COMPARATIVE PROPERTIES OF RAW RICE, PARBOILED RICE AND CONVERTED RICE

Property	Raw rice	Parboiled rice	Converted rice (a)
Milling quality	Only hard varieties mill without much loss Soft and dextrinous (Puttu) varieties involve considerable loss through breakages	All varieties improve in milling quality after parboiling Losses through breakages are greatly reduced	Milling quality is greatly improved Loss through breakage is quiet small
Appearance colour (uncooked)	Excepting with hard varieties the original shape is not retained Original colour is first seen but all varieties yield white rice on polishing	Original shape generally retained Colour deeper than raw rice—also affected by colour of husk Glassy exterior removed with continued polishing	Original shape retained Colour determined by that of the bran layer as also that of the husk—glassy appearance preserved even on prolonged polishing
Smell (uncooked)	Usual smell of raw rice	If steeped in hot water the smell of cooked husk is pronounced. If steeped long in cold water, secondary smell due to fermentation would be noticed.	Same smell as parboiled rice prepared by steeping in hot water
Taste (uncooked)	Normal taste of raw rice—tends slightly to soften on tongue	Somewhat cooked taste -remains hard on the tongue	Taste nearly the same but somewhat better than parboiled rice—remains hard on the tongue
Return of hulled whole grain to paddy.	Relatively small excepting in the case of hard varieties Even in the latter, the conditions of previous drying are important	Good return—over 80% with hard varieties—less with others	Good return
Composition of milled rice.	Usually about 40% of the total solid matter of paddy—predominantly starchy, percentage of starch increasing with milling	50-60% of the solid matter of paddy—original constituents largely retained	About the same as in parboiled rice—all the original constituents retained
Keeping quality resistance to insect attack	Does not keep well if left unpolished The oil of the bran layer turns rancid Insects are also attracted by such grains If fully polished the grain stands storage for some months	Reputed to stand well during storage Fairly resistant to insect attack	Reported to stand well during storage and resistant to insect attack
Vitamin content (b).	ug/g	ug/g	ug/g
Thiamine	0 54— 0 65	1 35— 1 74	1 9 - - 2 9
Riboflavin	0 28— 0 30	0 34— 0 47	0 35— 0 52
Niacin	18 5 - 20 6	45 0 —49 0	33 9 —52 0
Effect of washing before cooking	Vitamins, minerals and protein lost easily on washing, heavily milled rice losing faster than lightly milled ones	Vitamins, minerals and proteins fairly well retained Washing losses small unless heavily milled	Vitamins, minerals and proteins well retained. Washing losses quite small.
Cooking property.	Cooks quickly If recently harvested rice, cooks to a pasty mass Only hard varieties cook well Heavy loss in gruel if excess of water is used	Cooks rather slowly, the time depending on extent of parboiling All varieties cook well after parboiling Loss in gruel less than in raw rice	Takes more time to cook than even parboiled rice All varieties cook well Loss in gruel at a minimum
Smell of cooked rice	Quite pleasant—smell of the varieties usually pronounced	Characteristic smell modified by the nature of steep water - smell of variety not very pronounced	Same smell as good cooked parboiled rice
Taste of cooked rice	Usually soft on tongue—easily masticated	Somewhat hard on tongue—requires good mastication	Somewhat hard on tongue—requires good mastication
Digestibility of cooked rice	Usually quick to swell in the stomach—easily digested	Somewhat slow to swell—slow to digest.	Properties similar to parboiled rice.
Response to cooling.	Remains soft for several hours—can be used again either as such or after warming	Stiffens on cooling—turns fairly hard.	Stiffens on cooling—turns fairly hard.
Storage in presence of water.	Goes soft and spongy after sometime—starts fermenting	Softens but retains its shape under water—undergoes very slight fermentation—eating quality improved	Properties similar to those of parboiled rice.

(a) Properties of converted rice largely based on descriptions given by other investigators as also those who have tried it in India.

(b) The figures are quoted from the bulletin by Kik and Williams, but it is difficult to state whether they relate to the same varieties.

cooking. Parboiled rice takes more time to cook than raw rice. In the case of converted rice where the gelatinization of starch is carried to completion, a great deal more of fuel will be required A further factor to be taken into account is that a considerable part of the parboiling in India is actually done as a routine household operation. The orthodox communities usually like to use parboiled rice prepared by themselves

A problem of special scientific interest is the effect of gelatinization of starch on its digestibility. Although gelatinization is a step towards the hydrolysis of starch, the resulting product, is nevertheless, difficult to digest even after cooking, raw starch directly cooked to softness being always better digested. The same phenomenon is noticed during *in-vitro* hydroylsis of starch In the commercial manufacture of glucose, gelatinization of starch is carefully avoided because otherwise the conversion is incomplete The phenomenon is probably a purely physical one, the gelatinized starch, being a thick viscous mass, offering resistance to the penetration of enzyme or acid as the case may be As digestibility is an important factor in the popularity of any processed form of rice, it would be desirable to investigate whether gelatinization of the entire quantity of starch in the grain is necessary Parboiling represents gelatinization only at the surface and upto a small depth Some of the recent methods of conversion would involve the gelatinization of the entire quantity of starch

Other Methods of Conversion

During recent years, some Indian workers have also developed improved methods of rice conversion Samples prepared by one of these methods are highly attractive Other improved methods based on the same principle as parboiling should also be possible Thus, steeping in minimum quantity of hot or cold water followed by drying in a current of hot air may also produce the desired effect In such a case, many of the dehydration tunnels which have recently gone out of use will come in useful With a belt conveyer, the operation can be made continuous The gelatinization of the starch as well as the drying of the grain, would then follow in quick succession The possibilities of these and other simple methods should be carefully explored before making a final selection

Under the present conditions in the country, there is grave need for first conserving as much of the available human food as possible. This will apply particularly to rice of which there is considerable shortage Any method that will yield the maximum quantity of food material per unit weight of paddy. which will produce rice of high nutritive value ; and which will ensure good keeping quality should commend itself to the country. Considerations of taste are relatively of secondary importance when there is shortage of food. From this point of view, parboiled rice obtained by an improved method or converted rice by one of the recent methods would appear to be most promising. A good and careful selection has to be made and enforced throughout the country By taking a firm line of action, the present crisis in regard to rice can be tided over The solution will not, of course, be a permanent one. The country will definitely have to produce more food by increasing the yield from land If America can produce about 5,000 lbs. per acre, the average for India should be at least half this figure Our present average yield is considerably less, being near about 1,000 lbs per acre If we take into account the periodical floods, cyclones and crop failures, the average would be further reduced.

Enrichment of Rice by Incorporation of Vitamins

During recent years, the cheap and plentiful supply of mass-produced vitamins has led to the development of methods for the direct enrichment of rice In principle, these methods involved the impregnation of the most important vitamins of the B group together with iron and other accessories The treatment also includes some form of protective coating, so that the vitamins are not easily leached out during washing or cooking.

The patented process of Messrs Hoffmann—La Roche is highly interesting as it provides scope for incorporation with milled, raw or parboiled rice as one may desire The concentration of the vitamins especially thiamine and ribo-flavin, is carried to a high level so that the resulting product could be used as a premix for incorporation with even exhaustively milled raw rice. The mixture is stated to have a higher vitamin-content than any form of processed rice A further interesting feature is the level of riboflavin which colour the grains and could be used as a distinguishing feature.

From the information already available, there is no doubt that the commercially enriched rice will be an attractive product So far as India is concerned, the main practical difficulty will be in regard to its cost and its incorporation with millions of tons of raw rice. The danger of adulteration with spurious material will also be pretty considerable.

Enriched Rice May be a Luxury Product

Although the vitamins themselves may be pretty cheap—they are still costly so far as India is con-

cerned—the cost of impregnation and protective sealing will certainly add to the expense. Even if the premix alone is manufactured and marketed, there would still be the cost of packing and transporting a relatively bulky material, royalties, profits, etc, which would render the finished product much more costly than the vitamins incorporated. Such a product, however attractive, will be beyond the reach of the average citizen Assuming that it is marketed and mixed with rice on a large scale, imitations will soon start and lots of useless products, containing a little or no vitamin, will be passed off as the genuine article

Viewed from the practical angle, there does not seem to be much justification for all the trouble and expense of artificial enrichment The vitamins are directly assimilable and their use as such, would be preferable to the rather round-about method of impregnation With increased popularization, the vitamins themselves in tablet or other standardized form, will be taken up in increasing quantities by the consumers For this, large scale production of cheap vitamins under the Indian conditions will be needed. This will, however, be a different problem

Our First Problem

The immediate problem, so far as India is concerned, is to conserve the vitamins which are already present in the grain There are methods for achieving this end and these would require our first consideration If the bulk of the rice vitamin could be conserved, there would be practically no need for any supplementary quantity of either thiamine or niacin An extra quantity of riboflavin would be needed and this could be provided in some other manner

Need for Expert Study and Quick Action

The problems involved in rice processing are relatively simple and it would not be difficult to reach a quick solution A small competent committee, with the necessary background of experience could put through the various trials and reach a decision in under six months The Government should repose full confidence in their experts and based on the recommendation of the latter, the necessary immediate action should be taken The rice position in India is pretty acute and any delay will only add to the present difficulties

BOOK REVIEWS

Industrialisation through Electrification of Railways—by Sir Padamji P Ginwala, Kt Pp 67, price Rs 1/8/- only

In this brochure a strong plea has been made for the thermal electrification of the railways in South Bihar and West Bengal, as much for providing cheap electricity for industrial and agricultural development as for conserving superior grades of coal The burning of coal, in a locomotive boiler is in the opinion of Sir Padamji, the most wasteful way of using it, inasmuch as about 4 per cent only of its heat energy can be utilized Moreover, the consumption of high grade coal by the railways, amounting to over 30 per cent of the total coal raisings in the whole of India per year, constitutes a menace to the iron and steel industry and to many other key industries not yet established

The objections to proposals for railway electrification have been thoroughly examined and met and various aspects of the problem of electrification of E. I. R and B. N R. lines from Calcutta to Moghalsarai and to Chakradharpore, including main, branch and suburban sections, have been discussed. The author thereupon demands a public enquiry into the whole matter by an impartial Commission

At a time when various projects under Post-war Planning are under examination Sir Padamji has rightly drawn attention to a measure rich in possibilities and vital to the nation

N S.

Scientific Institutions, Societies and Research Workers in the Netherlands Indies.—Compiled by F and J G Verdoorn Pp. 425-460 (Reprinted from "Science and Scientists in the Netherlands Indies", edited by P Honig and F Verdoorn) Published by the Board for the Netherlands Indies, New York City, 1945.

The list, a reprint (interleaved with blank papers) of scientific workers of Netherlands Indies (at the time of Japanese invasion) will serve as a basis for various kinds of post-war planning The information contained herein are likely to be useful to scientists in other parts of the world as well. The list include almost all institutions and workers in all

branches of pure and applied science and technology and the list of workers engaged in biological and agricultural sciences is fairly complete

Copies of this reprint may be obtained, without charge, by writing to the Library, Board for the Netherlands Indies, Surinam and Curacao, 10 Rockefeller Plasa, 14th Floor, New York 20, N Y, or the Editor, *Chronica Botanica*, P O Box 251, Waltham 54, Mass., U.S.A.

A K G

Biochemistry and Morphogenesis.—By Joseph Needham, F R S, Cambridge University Press, Pp 785, Price 52s 6*d* net

This book by Dr Joseph Needham is of a piece with his previous encyclopaedic work on "Chemical Embryology" which brought together for the first time what we know about the biochemistry of the embryo in a critical and stimulating manner This book also maintains the same tradition of combining erudition with provocative thought on a fascinating subject *viz* the exploration of the biochemical agencies which bring about embryonic development and the enormously intriguing process of tissue-differentiation

As the author points out in his General Introduction the above problem can be dealt with in three ways (*a*) the study of the region between the largest chemical particles and the smallest morphological structures, that is to say, the study of para-crystalline aggregates, fibrous macro-molecules, etc, (*b*) the study of the chemical changes that occur in course of embryonic development and (*c*) the study of the more recently discovered hormones which appear to be of fundamental importance for morphogenesis including differentiation and hereditary development This last line has been mainly followed in this book

The subject is dealt with in three major parts (*a*) the morphogenetic substratum dealing with the embryonic material on which the morphogenetic hormones act, (*b*) the morphogenetic stimulants themselves, and (*c*) the mechanisms of morphogenesis

In each of these parts, the subject is dealt with in very great detail and in different aspects maintaining a critical and stimulating attitude throughout In so dealing with this subject there is hardly any modern aspect of biochemistry which is not brought in relation to the subject under discussion and attempts have been constantly made to get a picture from the facts, however blurred and incomplete that might be in the present state of our knowledge There are often philosophical touches in this discussion which are characteristic of Dr Needham.

The book is almost a complete reference book There is a glossary of special terms used in the book There is a very large bibliography of authors cited in the text and there are references to 585 journals, which indicate the sweep of Dr Needham's study There are several indices appertaining to 'general', animals, plants and genes

The book is truly outstanding among recent books on biochemistry and maintains solidly the reputation that Dr Needham's earlier work had built The writing of this book comes in easy style to Dr Needham, as he himself has been one of the great pioneering workers in this extraordinarily interesting field of biochemistry

B C G

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters]

A NOTE ON POLARITY OF MOLECULES IN RELATION TO THEIR ADSORPTION BY CHARCOAL

OPINIONS vary as to the influence of polarity of the adsorbate molecules and also that of solvent used, on the adsorption of substances by activated charcoal The present work was carried out with a view to throw light on some of those controversial points Effect of introducing different polar groups on adsorption was evident from the following series $C_6H_5COOH > C_6H_4(OH)COOH >$ and $CH_2ClCOOH > CH_3COOH > CH_2(OH)COOH > CH_2(NH_2)COOH$ — chloro-group has a tendency to increase the adsorption, while both OH– and NH_2-groups decrease it, the effect of amino being greater Effect of specific grouping into benzene ring was studied with compounds like $C_6H_5NH_2$, $C_6H_5(OH)$, C_6H_5COOH, and $C_6H_4(OH)COOH$ in different media like H_2O, $CHCl_3$, C_6H_6 with the result $C_6H_5NH_2 > C_6H_5(OH) > C_6H_5(COOH) > C_6H_4(CH)COOH$ (H_2O medium), $C_6H_5(OH) \geqslant C_6H_4(OH)COOH > C_6H_5COOH > C_6H_5NH_2$ (both in $CHCl_3$ and C_6H_6) Comparative study of adsorption of the individual compounds in these media revealed that the adsorption decreases in the series $H_2O > C_6H_6 \geqslant CHCl_3$ except in the case of phenol, the order being there $H_2O > CHCl_3 > C_6H_6$-strictly the order of decreasing polarity of solvent molecules

Our best thanks are due to Prof J N Mukherjee, C B E, D Sc, F N I, for his keen interest and helpful suggestion during the progress of the work The detailed work will be soon published in the *Journal of the Indian Chemical Society*

PROMODE RANJAN GUPTA
PADMALOCHAN DE

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Calcutta, 30-3-1946

DIGESTIBILITY OF SOYA MILK

SOYA-BEAN milk is a highly digestible product Experience in different parts of the World has shown that it is more easily digested than cow's milk In America and other countries, persons who are allergic to cow's milk or otherwise experience difficulty in digesting it, experience no such discomfort when using soya-milk In Canada, where there is no milk shortage, the sweet soya curd is favoured for feeding children as it produces no digestive disorders.

Our recent experience with feeding soya milk in child welfare centres has shown that even very young children can drink fair quantities of the milk without any discomfort Even babies have been fed on soya milk without any ill effect

Animal experiments carried out by us[1] has shown that soya milk protein has practically the same digestibility coefficient (90 9%) as cow's milk protein (89 2%) Observations by other workers[2,3] have also yielded similar results

As a striking contrast to this, we have found that the soya milk protein has a low *in vitro* digestibility Using the method of successive peptic and tryptic digestion as followed by Turner[4], we have found that the *in vitro* digestibility of soya protein is only 12 1 per cent in three hours as compared with 58 4 per cent as shown by cow's milk protein in the same period Both the peptic and the tryptic digestions of soya milk are very weak as compared with that of cow's milk

There is evidence of the presence of a trypsin inhibitor in the dilute acid extract of raw soya-bean, but this can account for only a slight drop in the enzyme activity It is doubtful whether this inhibitor is present in the milk which is obtained after boiling Anyway, its action could not be considerable

Soya milk forms a soft curd which disperses readily on either side of the iso-electric point Cow's milk curd remains as such over a wider range Soya-milk is deficient in calcium (28 mgm in 100 cc) as compared with cow's milk (112 mgms in 100 cc.), but this would not account for the low *in vitro* digestibility of the protein Soya milk is not curdled by animal rennet and this may have a bearing on the *in vitro* digestibility.

The high *in vitro* digestibility, as also the actual feeding experience, would strongly suggest that the conventional *in vitro* method cannot be applied to soya milk It may either be a case of something missing from the reagents as commonly used or one of the digestion actually proceeding in the body with a different type of enzyme system from that used in the *in vitro* trials

Further work bearing on the mechanism of the digestion of soya milk in the animal system is in

progress It is hoped that this study will throw fresh light on the digestibility of other vegetable milks as well

Department of Biochemistry, Indian Institute of Science, Bangalore, 26-4-1946.

N KRISHNASWAMY
S S DE.
V SUBRAHMANYAN

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CONGRUENCE PROPERTIES OF RAMANUJAN'S FUNCTION $\tau(n)$

The author has obtained the complete solution of the congruence

$$\tau(n) \equiv a \pmod{b},$$

where a is any number whatsoever, and b is any divisor of 24, and where the function $\tau(n)$ is defined by

$$x\{(1-x)(1-x^2)(1-x^3)\ \ldots\ \}^{24} = \sum_{1}^{\infty} \tau(n) x^n.$$

The roots of the congruence for the case $b=2$ have been previously obtained by Gupta[1] Here the roots for the cases $b=3$ and 4 only are stated Those for the case $b=8$ are not mentioned as it will occupy too much space The roots for the other moduli which are divisors of 24 can of course be derived from the above four cases The proof of these results will be published elsewhere

The roots of the congruence

$$\tau(n) \equiv 0 \pmod{3}$$

are (*a*) all numbers of the form $3m$,

(*b*) all numbers of the form $3m+2$, and

(*c*) those numbers of the form $3m+1$ which (expressed in the standard form) contain as a factor, either

(*i*) at least one prime of the form $3m+2$ raised to an odd power, or,

(*ii*) at least, one prime of the form $6m+1$ raised to a power whose index is of the form $3m+2$

The roots of the congruence

$$\tau(n) \equiv 1 \pmod{3}$$

are those numbers of the form $3m+1$ which have as factor, an even number (including zero) of distinct primes of the form $6m+1$ raised to powers whose indices are of the form $3m+1$, but none raised to a power whose index is of the form $3m+2$, the prime factors of the form $3m+2$ (if any) being raised to even powers only

If in the above formulation the word 'even' which occurs first, is replaced by the word 'odd' we get all the roots of the congruence

$$\tau(n) \equiv 2 \pmod{3}$$

The roots of the congruence

$$\tau(n) \equiv 0 \pmod{4}$$

are (*a*) the number $4m+i$, $i=0, 2, 3$ and

(*b*) those numbers of the form $4m+1$ which have as factor, either

(*i*) at least one prime of the form $4m+3$ raised to an odd power ; or

(*ii*) at least one prime of the form $4m+1$ raised to a power whose index is of the form $4m+3$, or

(*iii*) at least two primes of the form $4m+1$ raised to powers whose indices are of the form $4m+1$

The roots of the congruence

$$\tau(n) \equiv 2 \pmod{4}$$

are those numbers of the form $4m+1$ which have as a factor just one prime of the form $4m+1$ raised to a power whose index is of the same form, but have neither any prime factor of the form $4m+3$ raised to an odd power nor any prime factor of the form $4m+1$ raised to a power whose index is of the form $4m+3$

The roots of the congruence

$$\tau(n) \equiv 1 \pmod{4}$$

are the squares of those odd numbers which have an even number (including zero) of prime factors of the form $4m+1$, multiple factors being counted multiply

Finally the roots of the congruence

$$\tau(n) \equiv 3 \pmod{4}$$

are the squares of those odd numbers which have an odd number of prime factors of the form $4m+1$, multiple factors being counted multiply.

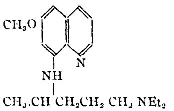
DEBABRATA LAHIRI.

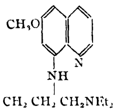
Statistical Laboratory,
Presidency College,
Calcutta, 29-4-1946.

[1] Gupta, H, *Proc. Benares Math Soc.*, 5, 17-22, 1943

ON ALKYLAMINO QUINOLINES AS ANTIMALARIALS

ATTEMPTS to control the outbreak of malaria by drug treatment have so far failed because of a lack of therapeutic agents capable of acting as a true casual prophylactic. "Plasmoquin" (I) has been found to have prophylactic value but due to its high toxicity the drug is not suitable for mass treatment Recently, however, considerable attention has been drawn towards the synthesis of various alkylamino alkyl-quinolines[1,2]—(Plasmoquin being the base of 6-methoxy-8-(ω-diethylamino *iso* amyl) amino quinoline (I) It may be recorded here that 6-methoxy-8 (γ-diethyl amino-propyl) amino quinoline (II) has also been prepared in this Laboratory as a highly viscous liquid b p 205° under 2 mm pressure The dihydrochloride of the base melts at 321° (Found N, 11 75, Cl, 19 77, $C_{17}H_{25}ON_3$, 2HCl requires N, 11 66 and Cl, 19 72 per cent) The base form salt with methylene-bis-salicylic acid melting indifferently at 150-60° (Found N, 5 85, $(C_{17}H_{25}ON_3)_2$, $3C_{15}H_{12}O_6$ requires N, 5 84 per cent) Similar other quinolines have also been prepared, details of which would be published elsewhere


(I)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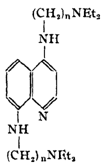
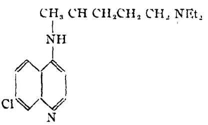

(III)


(IV)

The above methylene-bis-salicylate salts of 6-methoxy 8-(γ-diethylamino propyl) amino quinoline has been found in our Laboratory to be an effective gametocide[3]. Its effect on the sporozoites is being studied. But noting that quinine as well as 'Atebrin' contains a basic group in para position to the nucleur 'N' atom of the quinoline ring (atebrin being considered to be a benzo-quinoline derivative[4]), work is in progress to synthesise 4, 8-di-(dialkylamino alkyl) amino quinolines of the type (III) in the expectation of having a derivative effective against the malarial parasites at their different stages. It may be recorded here that strong antimalarial activity is also being noticed in 4-amino quinoline derivatives, particularly in 7-chloro-4-(δ-diethylamino-α-methyl butyl amino) quinoline[5] (IV)

U P BASU
P K DAS GUPTA

Bengal Immunity Research Laboratory,
Calcutta, 1-5-1946

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[2] Rohrmann and Shonle, *ibid*, 66, 1640, 1944
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[5] *Science*, 103, 8, 1946

BUD MUTATION IN PADDY

WHILE working in a field with the progeny of a dwarf mutant paddy* our notice was drawn to a few cases of abnormalities There was, it seemed, segregation of size in some cases and of colour in others, within individual plants These gave rise to the suspicion that bud mutation had taken place in them The other probable explanation would be that, by mistake, two or more seedlings of different kinds were planted in each hole. Some of these plants were uprooted and dissected but nothing definite could be established

To guard against any mistake of putting more than one seedling in a single hole, particular care was taken in later work, both at the time of seed-bed sowing and transplanting Nevertheless the abnormality was again observed in some plants On closer examination it was found that in some (i) there were tillers of two different sizes, *i e.*, besides the normal tillers, there were a few very much stunted tillers bearing leaves, ears and grains exactly like those of the original dwarf mutant, and in others (ii) the distribution of anthocyanin pigment was very different in different tillers, that is, besides tillers with purple colour in leaf sheath, stigma and apiculus, there were a few tillers absolutely colourless with regard to these parts of the plant body.

In order to find out as to whether long and short tillers in the first case, and coloured and colourless

* The mutant was obtained in a particular strain of paddy and was very conspicuous for its stunted stature. Its leaves were a little shorter than those of the normal plants and were quite erect, with deep green colour, the ears were short with very small grains. On breeding the mutant was found to be unfixable, the progeny segregating for size as well as colour distribution.

tillers in the second belonged to the same plant, the plants were uprooted and brought to the laboratory for dissection The roots were shaved off to expose the underground part of the stem and the connections of tillers with it, if any Careful dissection and examination of the plants showed that there were distinct connections between the underground part of the stem and the two different kinds of tillers The tall and the short tillers belonged to the same plant and so was the case with coloured and the colourless tillers

It was evident that mutation had taken place in the early stages of buds which afterwards gave rise to tillers of a very different character

An account of the detailed study of the mutant which is being carried on will be published later

Agricultural Research Station, Dacca, 2-5-1946

S Hedayetulla
S Sen

FURTHER STUDIES ON PARALYTIC ILEUS

Fortyone cases of acute abdomen, and pyloric stenosis have been investigated with a view to studying blood changes that are responsible for the onset and progress of paralytic ileus [1] Patients with a tendency to anhydraemia, hypochloraemia, alkalosis, and high K but low Na and protein level in blood are prone to develop paralytic ileus Cases of intestinal obstruction with delayed treatment show such changes to a considerable extent. The high K-content in blood is due to mobilization of this base from the muscle cells which are deprived of their glycogen content as well in the process of maintenance of fluid and electrolyte balance of blood The gut musculature also gets involved in such changes These precipitate the paretic stage of the gut Stasis of portal venous circulation as a result of gut paresis brings in anoxia The alkalosis is enhanced by the paresis of the gut and stasis of portal circulation and anoxia, as all these hinder the re-absorption of normal gastro-intestinal secretions (6-8 litres) Paralytic ileus becomes fully developed Scudder's[2] findings of high K-content in gangrenous condition of the gut and fall of this K-level in blood after resection of the gut and relief of obstruction have also been confirmed. Muscle cells working under anaerobiasis are damaged further by the simultaneous distension of the gut due to diffusion and non-absorption of gases and fluids Resultant low blood volume and B P , and highly viscous alkalotic anoxic blood precipitate kidney failure in its active attempt to filter out acid radicles from tubules. These findings were confirmed also in extra-abdominal cases of paralytic ileus. Thus the genesis, clinical features, so called hepato-renal syndrome, azotaemia and pathological changes in liver, adrenal gland, kidneys etc , appear to be due to a continued effect of alkalosis in blood with diminution in Na-kation and rising K-kation Evans'[3] method of estimating *p*H of blood colorimetrically (simplified by the author for bed-side purposes) can be employed as index to the preparetic, paretic and paralytic stages of the gut Animal experiments have been and are being carried out The results of these experiments are in agreement with the above findings and suggest that in early paretic or preparalytic stage of gut the treatment should be infusion of Ringer's solution or Ringer Locke's solution, protein glucose and sufficient quantity of oxygen In later stages or paralytic stage, Ringers or Ringer Locke's solution should be substituted by ordinary 5 per cent glucose saline and the rest of the treatment is same Decompression of Gastro-intestinal tract by gastric suction or by Miller Abbot's tube is an useful adjunct The changes in fluid and electrolyte balance in blood, extracellular and intra-cellular compartments appear to upset the basal metabolic gradients in gastro-intestinal tract (*cf* Alvarez's[4] discussions) These can explain also the reversed polarity and reversed peristalsis etc in cases of intestinal obstruction

The author takes this opportunity to express his sincerest thanks to Rai Dr K N Bagchi Bahadur, Professor of Chemistry , Dr J C Gupta, Professor of Pharmacology, School of Tropical Medicine and Lt - Col F J Anderson, Professor of Surgery, Medical College for laboratory and hospital facilities given

Sarashi Ranjan Mukherjee

Prince of Wales Hospital,
Medical College,
Calcutta, 5-5-1946

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[3] Dale, H H and Evans, G L , *J Physiol* , *64*, 167, 1920-21.
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LIFE HISTORY OF *AMBLYPHARYNGODON MOLA* (HAM. BUCH)—A DELICATE FOOD FISH OF BENGAL

Very little is known about the life-history, bionomics and development of the small variety of edible fresh water fish of Bengal. So, a reasonably complete knowledge of life-histories and habits of fish is needed as a basis for the adoption of adequate

measures for conservation of our fisheries We are giving below the gist of our knowledge of the life-history of a small sized Cyprinid, *Amblypharyngodon mola* (Ham. Buch) for the benefit of the other workers in the line The details and discussions will be given elsewhere.

1. *Breeding season*	May to October, peak period at the commencement of rain
2 *Mode of depositing eggs and fertilisation*	Partners remain in coiling position, during fertilisation for a short time when the ova are extruded in batches of 20 to 30 and are immediately fertilised by male Ova are not deposited in a single spot by the female A single female can lay 500 eggs
3 *Structure and nature of fertilised egg on extrusion.*	Transparent spherical, 0 6 mm in diameter, demersal, adhesive without oil globules with highly granular egg membrane
4 *Size of the egg after swelling*	0 8 mm in diameter
5 *Formation of yolk plug and embryonic ridge*	4 hours 5 minutes since fertilisation
6 *Completion of yolk invasion and formation of blastopore.*	6 hours since fertilisation
7 *Appearance of optic rudiment*	7 hours 15 minutes since fertilisation
8 *Appearance of body somites* .	7 hours 45 minutes since fertilisation
9 *Appearance of auditory vesicle, gill rudiment and adhesive gland*	10 hours 20 minutes since fertilisation
10 *Appearance of lens in eye, otolith and heart rudiment*	12 hours 20 minutes since fertilisation
11 *Appearance of median fin fold, anus and beginning of the pulsation of heart*	13 hours 20 minutes since fertilisation
12 *Period of incubation*	15 to 18 hours since fertilisation
13 *Length and characteristics of newly hatched larva*	On an average 2 mm Transparent without any pigment Eyes, otocyst, gill slits, median fin fold and a whitish patch on the yolk sac Not free swimming
14 *Appearance of yolk-sac circulation*	Generally 25 min after hatching
15 *Appearance of pectoral fin bud*	3 hours after hatching
16 *Appearance of Air-bladder*	6 hours after hatching
17 *Appearance of pigment cell and free swimming larvae*	12 hours after hatching
18 *Appearance of cornea, movement of pectoral fin*	24 hours after hatching
19 *Disappearance of adhesive gland*	48 hours after hatching.
20 *Formation of operculum and caudal fin rays.*	66 hours after hatching
21 *Appearance of food in the gut with complete absorption of yolk sac*	84 hours after hatching
22 *Appearance of nostril*	108 hours after hatching
23 *Appearance of dorsal fin bud*	10 days old larva
24 *Appearance of pelvic fin bud*	two weeks old larva
25 *Impressions of scales* .	one month old larva.
26 *Characteristics of fry*	Body greenish yellow, highly pigmented with minute scales.
27. *Developmental modifications of the facial structure.*	(*a*) Newly hatched larva—(2 mm stage) having oral pit, no nostril. (*b*) 48 hours after hatching—Mouth opens. (*c*) 53 hours after hatching—3 6 mm stage. Jaws of the mouth prominent, the upper being smaller than lower. (*d*) 133 hours after hatching—nostrils prominent as rounded openings.

28. *Developmental modifications of the fins* .	(*a*) 13 hours after fertilisation embryonic fin fold as narrow membraneous edging, rounded at the caudal end Completely absorbed in 3 weeks old larva
	(*b*) 24 hours after hatching 3 mm. stage Pectoral fins formed and show an irregular movement
	(*c*) 91 hours after hatching 3 to 4 rays appear in caudal fin and is heterocercal
	(*d*) Nine days old larva 5 5 mm stage. Anal and dorsal fin differentiating.
	(*e*) 12 days old larva—7 8 mm stage. Caudal find dyphycercal.
	(*f*) One and ½ months old larva Pectoral 15 rays, Pelvic—9 rays, Dorsal—10 rays, Anal—8 rays and Caudal—19 rays—all well developed
29 *Habitat of the adult* . ..	Generally surface feeders
30. *Food*	
5 mm to 10 mm .	After yolk absorption take minute unicellular algae
1 cm to 2 cm	Unicellular algae and protozoa of various nature
2 cm to 3 cm .	Unicellular algae—45 per cent, Protozoa & Rotifer—31 per cent, Crustacea—9 per cent, Unidentified mass—15 per cent.
More than 3 cm	Unicellular and filamentous algae—30 per cent, Protozoa & Rotifer—20 per cent, Crustacea—34 per cent, Unidentified mass—16 per cent.

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THE LISH (LISU) VALLEY TERTIARIES

IN 1938, Arnold Heim[1] observed that the boundary between the Tertiaries (Siwalik) and the older (Damuda) rocks in the Tista valley is not due to overturning of the strata, but to a "relief thrust", the older formations being thrust over a simple Tertiary anticline.

The geologic section along the Tista river given by Heim shows the Tertiaries folded into a normal anticline and not a reversed fold, the Damudas resting on it separated by faults

On the occasion of a visit to the Dalingcot colliery (Damuda age) up the Chunkhola, (or Ramtek river) a tributary stream to the Lish (Lisu) river in the S E part of the Darjeeling District, I made a rapid survey of the stratigraphy of the Lish river section. The Lish is a tributory to the Tista River running here about S 30°E—N 30° W *i e* almost parallel to the latter at a distance of about 5 miles to the east. It cuts nearly across the strike of the Tertiary strata, which have been exposed almost continuously along the whole length examined by me *i e* up to the confluence of Yangmakun Khola.

P. N. Bose[2] mapped this river section into a Damuda and a Tertiary (Siwalik) region, without attempting a subdivision of the latter (his survey was concerned more with the coal in the Damuda)

Along the Lish I could not reach the Damuda-Siwalik boundary which lies (according to P. N Bose's map) about a mile upstream from the spot that I reached But, in the Chunkhola (Ramtek Jhora) one can see conglomeratic sandstone belonging to the Tertiaries giving place up the Khola (*i e* stream) to more shaly facies of rocks dipping abruptly at one spot at 70° towards N 10°W The coal-bearing Gondwanas occur further up, dipping 65° towards N10°—20°W Up the Lish the Damuda-Siwalik boundary is conjectured to have the same peculiarities

The Lish River Tertiary section as studied by me is given here (fig 1)

The Tertiaries, thus, form a simple anticline, as in the Tista River, with local undulations towards east and west The following succession of beds are met with in ascending stratigraphical order.—

1 Sandy micaceous shales ; thickness not determined as these have not been followed further south. Dip 20° towards S30°W. These compare with Heim's (a) beds.

2. Micaceous sandstones, often of pepper and salt colour, with intercalated beds of nodular shales and rarely black slates. Thickness about 4500′ These compare with Heim's (*b*) beds.

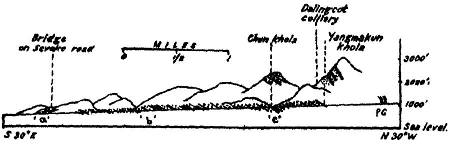

FIG. 1.

3. Coarse gritty massive thick-bedded sandstones with frequent conglomerate (with quartzite pebbles) layers. Thickness about 2600. These compare with Heim's (*c*) beds.

The Tertiary stratigraphy and structure in the Tista valley apparently extends to the Lish River, and Heim's interpretation of the Siwalik boundary against the pre-Siwaliks in the Tista valley is apparently verified in the Lish River section also. It, becomes more likely, therefore, that such explanation is applicable to the Eastern Himalayas in general.

But, P. N. Bose's observations on his point are different. From his survey between the Lish (Lisu) and the Ramthi Rivers he comes to the conclusion that,

(1) there is faulting at places (only two sections described) ; but facts observed "do not favour the idea of the entire boundary being a fault" (p. 243), and

(2) near Bagrakote-Nambong road east of Chunkhola Damuda coal-bed passes under Tertiary conglomerate and sandstones and the Tertiaries here rest on uneven surface of the latter. The sections suggest simple unconformable superposition.

This would mean that although Heim's interpretation of the Tertiary-Damuda boundary being a 'relief thrust' is not of local application,—it is neither universally true. More work along the boundary must be done.

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PROPERTIES OF SUB-FRACTIONS OF A SALINE SOIL FROM SIND

THE chemical, electrochemical and viscous properties of a number of hydrogen clays and their sub-fractions have been dealt with in several publications[1-11] from this laboratory. The properties of four sub-fractions (S_1 to S_4) isolated from the entire clay fraction ($<2{\cdot}0\mu$) of a saline soil from Sakrand, Sind, have been discussed in the present note. The sub-fractions having the following average equivalent spherical diameters were prepared by graded centrifugalization, using the method of Whit & Baver:[12] S_1 ($1{\cdot}4\mu$), S_2 ($0{\cdot}5\mu$), S_3 ($0{\cdot}2\mu$) and S_4 ($<0{\cdot}14\mu$). These were then converted into hydrogen clays (H-clays) by repeated leaching with 0·03N HCl followed by washing and were finally dispersed in conductivity water.

Chemical composition.—The percentages of SiO_2, Al_2O_3 and Fe_2O_3 of the four H-clays were determined by fusion analysis. Excepting the coarsest fraction (S_1), the percentage of Al_2O_3 in the ignited H-clay decreases from 33·9 to 29·3 and that of SiO_2 increases from 52·2 to 55·3 with diminishing particle size. The percentage of Fe_2O_3 varies irregularly from 12·2 to 14·6 in the four sub-fractions.

Nature of potentiometric titration curves with NaOH and the base exchange capacities of the H-clays.—The potentiometric titration curves with NaOH of the four sub-fractions reveal a weak monobasic acid character. The inflexion point characteristic of [illegible] neutralization of the acid occurs in the range of pH [illegible]2 to 7·6. The base exchange capacities (b.e.c. [illegible]), the amount of acid neutralized, calculated at the inflexion point increases from 10·0 to 38·0 milliequivalents (m.e.) per 100 g. of H-clay with [illegible] particle size.

[illegible]able H^+ and Al^{+++}-ions and their con- [illegible] towards the base exchange capacities of

the H-clays.—A considerable amount of Al^{+++}-ions are displaced from the H-clays by N-NaCl. This amount cannot, however, wholly account for the total amount of neutralizable acidity of the supernatant liquid above H-clay plus N-NaCl, indicating that H^{+}-ions also along with Al^{+++}-ions are also exchanged for the cations of the added salt. Exchangeable Al^{+++}-ions (Al_{ex}) increases regularly from 6.5 to 26.1 m.es. per 100 g. of oven dried clay with diminishing particle size. Exchangeable H^{+}-ions (H_{ex}) increases from 3.8 to 7.3 m.es. per 100 g. in the second fraction (S_2, 0.5μ) and then regularly decreases to 5.4 m.e. per 100 g. in the finest fraction (S_4, <0.19μ). H_{ex} and Al_{ex} contribute respectively 35.0, 19.0, 20.0 and 14.0 per cent, and 65.0, 54.0, 64.0 and 68 per cent towards the b.e.cs of the sub-fractions taken in the order of diminishing particle size.

Relation between the amounts of dye adsorbed by the H-clays and their base exchange capacities.—The four sub-fractions taken in order of diminishing particle size adsorb 7.5, 23.1, 29.8 and 37.1 millimoles of methylene blue per 100 g. of the clay from a 0.02 per cent solution of the dye. It is rather interesting to note that the base exchange capacities of the four sub-fractions, as calculated at the inflexion point in the titration curve with NaOH are 10.0, 28.0, 34.0 and 38.0 m.es. per 100 g. of clay, also taken in the order of decreasing particle size. The agreement between the two sets of values may be considered fair in view of the differences in the nature of the experimental technique used for measuring them.

Specific surface and base exchange capacities per square metre.—The specific surfaces, A_1 and A_2, of the four sub-fractions calculated respectively from (1) the average equivalent spherical diameter of the particles and (2) the amount of methylene blue adsorbed, show that both A_1 and A_2 increase with diminishing particle size, the values for A_2 being 10-15 times greater than the corresponding values of A_1.

We take this opportunity to offer our sincere thanks to Prof J. N. Mukherjee and to Dr R. P. Mitra for their kind interest in the work. Our thanks are also due to the Imperial Council of Agricultural Research, India, under whom one of us (B.C.) is employed, and to the University of Calcutta for awarding a research scholarship to the second author (P.R.G.).

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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. AUGUST, 1946 No. 2

HEALTH SURVEY AND DEVELOPMENT

BHORE COMMITTEE'S RECOMMENDATIONS—II

Medical Research

TO enable our readers to understand the implications of the Bhore Committee's recommendations with regard to Medical Research in India, we propose to give a short account of the background under which medical research has developed in India

Between 1835, when the first western type of medical college was established in India, and 1900, no medical research of good quality was undertaken and no research organization existed in the country, although the then workers in India came to know of the epoch-making discoveries of Pasteur, Lister, Robert Koch, Virchow and other workers in Europe

The need for research was felt by the Government of India early in the 20th century, and a Medical Research Department was created in 1907, with 12 officers consisting of Directors and Assistant Directors of certain laboratories, which were mainly concerned with routine work like the preparation of vaccines and sera and laboratory examinations of pathological materials and water analysis Some of the laboratories belong to the Central Government (Pasteur Institute of India, Kasauli—established 1900; Central Research Institute, Kasauli—1906, when these two were amalgamated, Imperial Serologist—1924; Nutrition Research Institute, Coonoor—1930; All-India Institute of Hygiene and Public Health, Calcutta—1932; Biochemical Standardization Laboratory, Calcutta—1937, and Malaria Institute of India—1939), while some to the Provincial Governments (Haffkine Institute, Bombay—1896-1899; King Institute of Preventive Medicine, Madras—1903; Pasteur Institute of Southern India, Coonoor—1907; Pasteur and Medical Research Institute, Shillong—1917, and School of Tropical Medicine, Calcutta—1932). Work of routine nature has remained the major interest of almost all these institutes, contrary to ideals of a progressive research organization, and research work became at best "the spare-time activity of enthusiastic individuals" The "throttling effect of routine work on research, even in laboratories in which research was intended to be the primary function" has been recorded by the Bhore Committee

In 1906, the Government of India created a cadre of bacteriologists under the Bacteriological Department, later called the Medical Research Department, with 13 medical officers, mostly belonging to the Indian Medical Service, who were posted to the various central and provincial laboratories This number has been increased and decreased from time to time, the present sanctioned strength being 30, half of which is reserved for members of the Indian Medical Service and the other half is open to both I M S and non-I M S candidates Actually, at the present time, there are only 12 officers in this department (6 I M S and 6 non-I M S), the rest having been called to military duty

A quasi-official body deriving most of its income from the Government of India, called the Indian Research Fund Association, was created in 1911, with among other objects, "to initiate, aid, develop and coordinate medical and scientific research in India, to promote special inquiries and to assist institutions in the study of diseases, their prevention, causation and remedy," under the Chairmanship of the Hon'ble Member for Health, Government of India, with 10 other members of whom only 4 are non-I.M.S. and non-official, in contrast to only 2 officials in a council of 11 members on the Medical Research Council in Great Britain. Two eminent

British workers were invited by the Government to advise them on the organization of medical research in India—(1) Professor Starling in 1920 and (2) Sir Walter Fletcher in 1927. These gentlemen noticed the over-officialization of the research posts in the country and suggested the establishment of research foci at university centres in order to facilitate "frequent intellectual intercourse between workers of different sciences providing a stimulus which keeps the brain active and maintains the spirit of enquiry at a high level." The Fletcher Committee stated "that intellectual contact with great workers in Physics, different branches of Chemistry and Biology, including Zoology, was a great factor in stimulating that side of medical research which was called "basic." It was also recognized that "clinical" research had always given a stimulus to "basic" research in medicine, except in a very few isolated instances The Annual Report of the Medical Research Council of Great Britain for the year 1928-29, when Sir Walter Fletcher was himself Secretary, contains the following statement

"It has always appeared to the Committee that it would be disastrous to the general intellectual interests of the country and no less damaging to the progress of research itself, if the main body of research workers were maintained in an isolated service detached and apart from the general system of scientific and medical education The importance of linking medical research work with university teaching is so universally admitted as to need no discussion here"

It was further stated in the report that one of the strengths of the medical research organization in Great Britain was that it interlocked with the educational system of the country and that it was an organization which proceeded on the wise premise that, in the case of science, the best way to get the fruit was to cultivate the tree It proved both successful and economical in the long run

Prof A V Hill who was recently invited by the Government also drew attention to the lamentable lack of organization of medical and public health research which prevails in India today. We believe his suggestions were also taken into consideration by the Bhore Committee in formulating their proposals

The Indian Research Fund Association, with a grant of Rs. 5 lakhs from Government, chiefly focussed its attention on communicable diseases As the programme was made from year to year, long-term research was seldom undertaken Decisions were frequently made by an official majority often violating the fundamental aims of integrated research into the unsolved health problems in India and of its possible applications. The emphasis had all the time been on the centre without a sufficiently co-ordinated "brain trust", and a peripheral development of research organizations was overlooked The question of establishing a Central Research Institute in a salubrious climate, away from university centres and of clinical material, has been mooted since 1920, under strong non-official opposition. With the establishment of the All-India Institute of Hygiene and Public Health (1932), the matter has remained in abeyance, but we notice that the Bhore Committee wants the All-India Institute of Hygiene and Public Health to be dovetailed to the proposed All-India Medical Institute, presumably the aim being to keep the central organization under as much official control as possible Because of these tendencies the Indian Research Fund Association has only been able to do piece-meal research, unlike research in the United States, England and Germany, where it has been chiefly the product of universities or of industrial organizations The I.R.F.A., as it is now constituted, is incapable of stimulating and developing coordinated research with other fields of research activity throughout the country Its programme of work is not based on a thorough survey of the needs of the country and does not indicate any graded planning Most of the research workers under the Association, who represent some of the best talents in the country, get a starvation wage and their *temporary* services are extended from year to year without any privileges of pension or gratuity even after 15 years' work Such a system could not continue in any other country, even for a single year No wonder that Sir A V Hill has strongly criticized this system of running education and research *on the cheap* If such an organization was capable of pursuing a well-planned and coordinated progressive policy, it would have done it within the last 35 years of its existence

Apart from university centres, non-official organizations, like the Tata Institute of Pathology, Bombay, the Indian Institute of Science, Bangalore, and the Indian Institute for Medical Research, Calcutta, which have carried on very useful research work in medicine and public health, have received a niggardly treatment from this Association

No attempts have been made to integrate and organize medical research in medical colleges in India. The Bhore Committee admits that there is at the present moment "almost complete absence of organized medical research in the various departments of the medical colleges," the chief causes ascribed being (1) ignorance on the part of the authorities of the importance of research in relation to the maintenance of a high standard of teaching and the development of the right attitude of mind in the students ; (2) insufficient personnel of the right type ; (3) the prevalent practice of employing part-time teachers on low salaries which compels them to engage in private practice in order to make a reasonable living ; (4) insufficiency of suitable equipment and in some cases lack of adequate accommoda-

tion and (5) inaptitude or lack of interest in research on the part of many of the teachers employed Even where whole-time workers, European or Indian, have been employed, a large majority of them violated the principles by surreptitiously or openly engaging in remunerative private practice, to the detriment of clinical or basic research in the institutions concerned The Report further states "that no facilities exist in India for training the young alert minds of the country in a scientific approach to medical matters and that this lamentable deficiency probably accounts for the indifferent attitude to research on the part of many of the teachers in medical colleges." It is no wonder that the "achievements of the past have not been commensurate with the unequalled materials available for research or for the present needs of the country " The need for training medical research workers has been acknowledged and certain suggestions have been given, such as the provision of scholarships both at the university centres in India and abroad With regard to their training at the University centres, it presupposes, of course, that the institutions concerned must be adequately equipped, the training personnel adequately trained and their working conditions permit of sufficient emoluments and of freedom from routine work Unless these centres are properly organized, it is no use giving scholarships to selected candidates With regard to foreign scholarships, the objective should be first, to determine the major lines of attack in the causes of deficient knowledge on the problems presented at peripheral rural, urban and industrial centres of population and then, to select the number and quality of personnel required to solve the problems in each direction Already these principles are being violated, particularly in the provincial spheres, where the selections are being made in a haphazard fashion and without any relation to the broad objectives stated above It is evident that where vital national health problems are to be solved communal and extraneous considerations should be kept in the background, at least in the initial phases of the planning. It is painful to note that these unscientific considerations are further vitiating the principles and objectives.

The Committee visualizes a four years' course of training for research workers at the proposed All-India Medical Institute. We have already expressed our opinion for the establishment of 4 such centres (*vide* our Editorials, Vol. X, pp. 97-101, 1944-45 and Vol. XII, pp. 1-5, 1946-47). Although the Committee visualizes the establishment of "regional laboratories" at selected centres, it does not state where these regional laboratories should be located. Without determining the need for the solution of fundamental unsolved problems at the peripheral centres, these cannot of course be usefully located and linked to a coordinated whole. If analysis of a routine nature does not become the sole concern of these regional laboratories, they can be very usefully converted into research institutes in the neighbourhood of university teaching centres Properly speaking, the so-called central or larger research institutes should be concerned with the study of problems which are too big to be tackled at the regional smaller institutes, as has been done in the U S S R The establishment and expansion of these regional laboratories visualized in the report are sketchy and fragmentary. We notice with amazement, however, that the worst criticism has been made of the laboratories maintained by the Government of Bengal, in spite of the presence of the Calcutta School of Tropical Medicine and the All-India Institute of Hygiene and Public Health in this province This ought to serve as a pointer to the dangers of disjointed planning

We are glad to find, however, that research into social and environmental factors connected with health and diseases has been properly emphasized, but we regret to find that a focus for clinical research and research into social and environmental factors related to health and disease has been proposed for implementation at the All-India Medical Institute alone and not at the University Medical Schools in the country generally This we are constrained to point out is a short-sighted proposal

The Committee is conscious that research work now being done under the Indian Research Fund Association is narrow and restricted in scope and that there is an urgent need to reorganize it on a broader basis with a larger allocation of funds It is stated that in formulating their recommendations for organization of medical research in India, the Committee examined in detail the organizational set-up of bodies like the Medical Research Council of Great Britain, the National Medical Research Council of Canada and the National Research Council in the United States, all of whom enjoy great latitude in the formulation of their research policy and with the exception of the last named body *complete freedom in the disposal of the funds allotted to them*. In trying to propose the formation of a similar central body for India, the Committee ignored the proposals of the National Institute of Sciences of India and of eminent scientists in India, the advantages of which were briefly indicated in our Editorial in the previous issue of this Journal.

The Committee's proposal is to constitute a statutory organization consisting of (1) a *Scientific Board*, which would be the executive machinery of the organization, and (2) an *Administrative Body* which will form the link between the Board and the Government of India and exercise general supervision over the working of the organization. The Scientific Board is proposed to include medical research workers

of standing and experience, representatives of universities and medical colleges, representatives of the principal scientific bodies in India, prominent workers in the field of public health and clinical medicine, non-medical representatives of allied and fundamental sciences, and persons with experience of health administration. The Administrative Body is proposed to consist of (*a*) the Minister of Health in the Central Government, (*b*) representatives of the Government departments of Agriculture, Industry, Labour and Finance, (*c*) a representative of the Council of State, (*d*) 2 representatives of the Legislative Assembly. It is suggested that the Director-General of Health Services to the Government of India will be in attendance at all meetings of this body. The main functions of the Central Medical Research Organization visualized above will be (1) the formulation of policy in regard to future development of medical research in India, (2) stimulation of research activities in the provinces, universities and medical colleges, and (3) co-ordination of such research activities throughout the country. It is recommended that the Indian Research Fund Association should be merged into the Central Medical Research Organization proposed. In fact, from a critical examination of the proposals, it will be seen that the scheme is nothing but a polished version of the present defective organization, called the Indian Research Fund Association. It seems that the administrative set-up recommended by the Bhore Committee for managing the Central Medical Research Organization again shows the old tendency to keep everything under official auspices and not to allow unfettered power to scientists to plan progress, to spend funds and to administer the organization. The Board of Medical and Public Health Research will gain immensely in status and efficiency if it is linked to the proposed National Research Council, composed mainly of scientific workers.

It seems that the question of linking the medical and public health research organizations to the proposed National Research Council of India, has received lukewarm attention. In spite of wide differences in the economic and political conditions between Great Britain, Germany, America and Russia, the basic principles of organization of scientific research evolved in those countries, at wide intervals of time, appear to be generally identical. In the U. S. A., the National Academy of Sciences, with a membership of 450 scientists, has a smaller body called the National Research Council, created during the first world war (1916) with a membership of 250. The medical sciences form one of the nine major divisions of the Research Council. During the last war in order to co-ordinate all the activities and to utilize the facilities of the university and industrial laboratories, a further organization has been formed known as the Office of Scientific Research and Development, under which is the Committee of Medical Research and under the latter about 1200 scientists are serving on some 100 advisory committees, with enough money at its disposal, to initiate and organize research. The British system, though more on the conservative side, is analogous in many respects.

The Russian system appears to be the most progressive, as has to be expected in a country where problems are not faced separately, but as an interconnected whole and where science forms an integral part of the State machinery. As the supreme scientific body in the country, the Soviet Academy of Sciences is charged with the duty of settling the general trends for research in accordance with the immediate and vital problems of the State, and with co-ordinating the plans of the various research institutes with the general State plan. Thereafter 840 research institutes get busy about the problems entrusted to them. The general direction of scientific work throughout the Union is in the hands of the Academy, but the Research Institutions under the Academy represent only a small fraction of the research carried on throughout the country. The main bulk of research is carried on by the university research laboratories and by the research institutions under the control of the different commissariats. Although the main function of the university and technical schools is educational, yet each of them has its research laboratories which are linked very closely with those of the academy. The idea behind the organization is that there should be a two-way flow of problems and solutions. The problems of rural, urban and industrial communities are passed on to larger institutes from the peripheral institutes, where technical knowledge and necessary personnel are adequate to solve them. Similarly any fundamental discoveries made in the universities or academy are immediately transmitted to the peripheral centres of work. This two-way flow operates not only in medical and public health fields but also in the field of agriculture and other fields of human activity. Medical research must not be considered as aloof from researches in basic sciences such as physics, chemistry and biology. Rapid developments have been witnessed during the last 25 years in many of the basic sciences contributing progress and new ideas to medicine and public health science. If medical research is divorced from a living contact with other sciences, co-ordinated progress will necessarily be hampered.

The situation in India to-day is pathetic. Many problems of disease and health hazards still remain unsolved, while problems already solved are not applied in practice. Definite advantages are expected to accrue in utilizing the results of researches for social welfare, if the central organization has an *Utilization Section* attached to it for purposes of co-

ordination of activities with other sections and to see that the results of research are utilized for the welfare of man. An Utilization Section can only function usefully if the planning is technically sound. The Committee's timid approach in many directions is exemplified by its approach to the problems of the supply of drugs and appliances and on how to deal with the indigenous systems of medicine, which are being resorted to by approximately 90 per cent of the population, simply because the drug resources of India have not been properly tapped. No attempts have been made to ascertain the needs of the country with regard to the supply of medical appliances and with regard to the testing of the ideology and methods in the indigenous medical sciences with the help of modern scientific methods. The Committee has left these matters for future consideration of the provincial governments and other bodies. In spite of 150 years of contact with Europe, India has still to import most of her technical instruments and apparatus needed for the diagnosis, treatment and investigation of diseases. Compare this with Soviet Russia. In 1912, she imported 50 per cent of the total value of drugs used; by 1934 the imports were only 3 per cent of the total value; by 1940 she was almost self-sufficient. By the middle of 1935 there were 2500 x-ray apparatus of Soviet manufacture already in use; quartz lamps and diathermy apparatus of home production were also coming to the market; the out-put of satisfactory surgical needles and syringes was reaching a high figure, and by the close of the same year, a supply of some 850 dentists' chairs was proceeding from shops established a few months ago. During the war the home production must have been enormous to keep pace with the operations on wide military fronts.

Let us look at India. Synthetic drugs for the cure of the most important disease in the country, namely, malaria, could be manufactured by various laboratories, but the State machinery discouraged the manufacture of the basic chemicals necessary for production of these drugs, while it encouraged the purchase of anti-malarial drugs from other countries.

A dissentient note by 2 of the members of the Committee rightly emphasizes the necessity for encouragement of the manufacture of biological products by private commercial concerns, while the State institutes should be mainly concerned with the formulation of standards of purity and efficacy and with enforcing the production of pure and efficacious products according to the standards laid down by the State, allowing the Government institutes to devote more time to solving problems of research.

Without a separate Department of Planning and Development, co-ordinated national planning is not possible. Such a department was formed during the war and did much good work, but the recently appointed Caretaker Government has put back the wheels of progress by abolishing the Department and by taking over the functions to their respective departments. The lack of vision and lack of technical quality behind the administration, which had placed handicaps to progress in the past, are still continuing. It is hoped that the National Government, when it comes, will restore this department to its legitimate place, and will take note of medical and public health research, the need for which has been visualized in a short resolution in the Report of the National Planning Committee, and that medical and public health research will be closely linked with other academic departments, thus forming an integral part of the whole research machinery of the State.

It is surprising that the Committee has left out the financial implications of their recommendations. Modern public health, which is an integral part of the social services like education, agriculture, animal husbandry, co-operatives and industries, has to be paid for. Expenditure on research is an investment for better methods of achieving the object. The percentage of revenue spent on preventive and curative medicine in Britain is nearly seven times that spent in India. Even that is considered to be inadequate and a recent public health memorandum has pressed for an allocation of £7 millions annually for medical and public health research in England alone. How much more is needed for India can easily be imagined. The following quotation from Bernal is pertinent in this connection.

> "Needless to say, Indian science, like everything else in India, except the English Civil Service and the Army, is starved of funds. The total annual sum available for scientific research in India is probably not more than £250,000, which would be equivalent to 150th of a penny per head of population, or 0 015 per cent of the miserable national income of £1,700,000,000. Yet there is hardly any country in the world that needs the application of science more than India."

An expenditure of 0·1 per cent of the national income for research in India will amount to Rs. 2·6 crores, 20 per cent of which or Rs. 50 lakhs can easily be allocated for medical and public health research. Scientists in India have pleaded for the allocation of 1 per cent of the national income for research into the various problems contributing to a forced march for scientific research and modernization. While money is made available, it has to be seen that a "Rolls Royce" administration is no longer maintained in a "bullock cart" country, as it is being done now. In many departments of social welfare research, the salaries of the superior staff swallow up 60 to 80 per cent of the total departmental budget. This is a financially unsound policy and needs modification.

Sir Edward Mellanby, in his Rede Lectures before the University of Cambridge, on the 28th

April, 1939, stated that any State scheme affecting health would only be as effective as medical knowledge at that time allowed it to be. The evolution of modern medicine and of medical research, particularly towards the latter years of the last century helped to banish, in western countries, communicable diseases, like plague, malaria, typhus, cholera and smallpox, to adopt better standards of sanitation and cleanliness and to raise the standard of nutrition, physique and longevity. The results of research have lagged behind in application, partly due to ignorance or laziness on the part of the public, to lack of political and social interest, to administrative inertia and to such economic and social restrictions as prevent people from attaining the nutritional and hygienic conditions necessary for healthy existence. "The extent of this lag," said Prof. Mellanby, "would depend on medical leadership, on doctors themselves, on public health authorities and on the intelligence of the public. The State must also make up its mind how best to use the newer knowledge and whether vested interests would be permitted to stand in the way of such application "

To conclude in the words of Prof. Mellanby.

> "Medical science and its instrument, medical research, have justified themselves For every problem, social and economic, the only solution is more knowledge and more wisdom to use this knowledge There is no limit to the amount of knowledge to be gained, if the medical scientist is given the opportunities and facilities for his work Would that the same could be said about the wisdom necessary to make the best use of this knowledge!"

WERE THE RIGVEDIC ARYANS PROTO-NORDICS ?

N M CHAUDHURI,
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THE view generally accepted at the present time is that the Rigvedic Aryans were a fair-skinned, fair-haired, dolichocephalic, leptorrhine race, who came probably from the distant Eurasiatic steppe lands to India about 2000 B C They are held to have been of Proto-Nordic race, that is, they belonged originally to the race from which the European Nordics sprang later Thus dolichocephaly, leptorrhiny and absence of pigmentation in hair, eye and skin colours were the characteristics of the Rigvedic Aryans In the present paper, it is proposed to examine this view held by many European and Indian scholars and also to find out the actual basis of it.

For this purpose two important points have to be considered first. What is the Proto-Nordic type and what evidence in skeletal remains there is for determining the racial type of the Rigvedic Aryans?

The term Proto-Nordic was first used by the distinguished anthropologist Dr Haddon. It is of the same class as the terms Proto-Australoid, Proto-Alpine, Palae-Mongolian etc and means a hypothetical race from which the Nordic races of Europe are supposed to have descended. According to Haddon, it may be supposed that some of the earliest members of the northern groups of Neanthropic men in eastern Siberia wandered afar when they were still dolichocephalic and otherwise of undifferentiated type ; they may be supposed to be of the same stock from which the Proto-Nordics sprang.[1] The Proto-Nordics were the descendants of the dolichocephalic steppe folk of western Asia and south Russia, who spread westward at variour times From these western branches sprang the Nordics of Europe The original home of the Proto-Nordics was the western steppe lands north of the series of western plateaux in Asia and eastern Europe.[2] Among the branches of the Proto-Nordic race in Asia, Haddon mentions the modern Kurds, the old Kimmerians, Mandas, Medas, Kassites etc. The Kassites and Hittites had Proto-Nordic leadership[3] Similarly, the Sakas or the so-called Scythians, well known in Indian history, had Proto-Nordic leadership[4] These vague statements mean nothing more than that there were Aryan speaking elements among some of these races According to Haddon, the original home of the Indo-Afghan was close to whence the Proto-Nordics emerged This means that he does not hold that the Indo-Afghan or the Indo-Aryan of Risley is really Proto-Nordic, but he believes that because the Indo-Afghan is dolichocephalic and leptorrhine he may be distantly connected with the Proto-Nordics. In Europe the *Kurgans* of the steppe and parkland regions in south Russia are attributed to a dolichocephalic race, probably Proto-Nordic. The Letto-Lithuanians are regarded as representing a passage type from the Proto-Nordic to the Nordic[5]. The Nordic races in Europe are mesocephalic, while the dolicho types are generally held to be Mediterranean, originally, a Eurafrican element.

Dr B. S. Guha is a protagonist of the Proto-Nordic theory in India. He thinks that the dolicocephalic, leptorrhine, partly blond type found north

of the Himalayas is the Proto-Nordic type, full blondism being confined to north Europe[6] He holds that the type is preserved in comparative purity among the Kaffirs, Khos etc. of the Hindukush, mixed with another type among the Badakshahis, Pathans etc. While the type is found in comparative purity among the northern mountain tribes, it is to be found in some measure in the United Provinces, Bihar and Bengal[7]

Haddon's Proto-Nordic type is then (represented by the Kurds) dolichocephalic, leptorrhine and blond Guha's Proto-Nordic type is dolicho, leptor, and partly blond, represented by the Hindukush tribes

The Vedic Aryan type is believed to be Proto-Nordic by Dr Guha He writes, "We have no skeletal remains from ancient India which can be definitely attributed to them, but in those recently discovered in the Dharmarajika monastery at Taxila we probably get some idea of their racial type, though of much later times. The monastery was sacked by the White Huns in the 5th century A D, and with the exception of one, all the human skeletons were probably those of the monks who occupied the monastery"[8] The type is dolichocephalic but different from other dolichocephalic types so far found in India It is characterized by comparative broadness of the skull, highly pitched narrow nose, well built face and powerfully made jaw "At the present moment the type is found as the dominant element throughout the North-Western Frontiers among the various Pathan tribes Among the tribes living in the valleys formed by the upper Indus and its tributaries of the Swat, Panjkora, Kunar, and Chitral, it is found in its purest forms, especially in the Kaffir tribes of the Hindukush mountains."[9] He says that this race represented by the northern mountain tribes "can be more accurately described as partly blond or Proto-Nordics"[10] Thus we find that, according to Guha, the Dharmarajika type is the same or almost the same as the Hindukush type. The former type is taken by him to be akin to the type of the Vedic Aryans. Among the Pathans there is a mixture of a coarser element called the Oriental type.[11]

In a later work Dr Guha gets over the hesitation which marks his earlier writing and the Dharmarajika type is more emphatically affiliated, on the one hand, to the Vedic Aryans and to the Hindukush and Pathan tribes, on the other, marked among the latter two with Dinaric and Oriental elements[12]

The Dharmarajika type which is the same as or akin to the racial type of the Vedic Aryans, according to Guha, is marked by comparatively broad skull, highly pitched narrow nose and powerful jaw As this element is said to be found in its purest form in the Hindukush tribes, specially in the Kaffirs, to the above characteristics may be added rosy white complexion, grey or grey-blue eyes, and light brown or chestnut hair[13] This completes the picture of the Vedic Aryan type. Guha adds, "From references in the ancient Vedic literature, their northern home, light skin and hair colours seem indisputable"[14] This is the dolicho. leptor., partly blond Proto-Nordic type of Guha

Now the Hindukush tribes among whom the Dharmarajika type is said to survive in its purest forms do not represent an ethnically homogenous race

Linguistically, the tribes living south of the Hindukush have been divided into two groups, the western group speaking Dardic language and the eastern group speaking Burushaki language, with the Kaffirs occupying an intermediate position between the Iranian and the Indian Among the western group of tribes Dr Guha has discovered a small Mongoloid element characterized by flat, broad nose, a variant of the Oriental type characterized by long head and aquiline nose, a tall long headed strain with straight nose and a fourth with medium stature, short head and a long nose which is often straight This last strain is said to be Pamiric race of Ujfalvy[15] Among the eastern group of tribes also he finds the presence of the same Mongoloid strain responsible for mesorrhiny, variant of the Oriental strain, Dinaric strain and a tall, long-headed leptorrhine strain in varying proportions among different tribes He writes, "It would appear that the basic racial type is the same dolichocephalic strain with prominent long nose which was found to be underlying the population of the western valleys . . . We may consider therefore that this variant of the Oriental race is the dominant strain in the N W Himalayas and may be regarded as the characteristic type of this region"[16]

This is the principal race of the region. The Dinaric strain with medium eyes and hair but light skin colour which is strongest among the Khos and Buroshos "has spread from the Central Asiatic regions around the Takla Makan desert where its presence has been known from the earliest times, and among the tribes of the Pamirs it is found in its purest form"[17] The tall dolicho type with straight nose is akin to the Aral-Caspian type and "is related to the strain which forms the dominant element in the north European races"[18]. In cephalic index, stature, nasal form and shape of the face, the Kaffir tribes most closely resemble the Aral-Caspian type.[19] The presence of a small percentage of blondism (15 p.c) among the Kaffir tribes, likely to raise doubt about the identification, is explained away by a reference to Dixon's opinion[20] that the original skin colour of the Eurasiatic steppe folk was fair (with brown hair) with an inherent tendency towards blondism.[21]

The conclusion from the above is that the Aral-Caspian type (dolicho, leptor., long but often straight nose with inherent tendency towards blondism) is the Proto-Nordic type, and that this type is best represented by the Kaffir tribes of the Hindukush

If the Vedic Aryans were Proto-Nordics they resembled the Kaffirs more than any other Hindukush tribe

It has been noted above that one of the elements discovered among the Hindukush tribes by Dr Guha is the Dinaric element The Dinaric element means characteristics of the races inhabiting the Dinaric Alps The term Dinaric has been substituted by Guha for the term Armenoid used in his earlier writings The use of these terms for characterizing the brachycephalic elements among the Hindukush tribes is open to objection There is, however, no room for discussing the question here For the purposes of our present investigation it may be observed that the term means only non-Mongoloid brachycephalic element The brachycephalic element among the Hindukush tribes has been affiliated by Ujfalvy and others to the Pamirian or Irano-Pamirian type

Joyce analyzing the anthropometric data collected by Sir Aurel Stein gives the following cephalic indices Kaffir 76 88 (Risley gives Kaffir 76 9, Hunza 78 8, Nagar 75 4), Chitrali 80 26, Mastuji 80 57, Dard 75, Pathan 76 The percentage of white rosy skin colour is 78 among the Kaffirs, 100 among the Chitralis, 03 among the Mastujis and brown 22 among the Kaffirs He writes that among the Pamir group the Chitrali must be regarded as influenced by some extraneous element, probably that which entered into the composition of the Kaffir, some strain of the Indo-Afghan Again, the element that differentiated the Kaffir from the Pamirian folk proper is evidently not Iranian ; it is Indo-Afghan The Dard are closely related to the Chitrali [22] He writes, "The original inhabitants of the Pamirs and Takla Makan desert including cities now buried beneath the sand is the type described by Lapouge as Homo Alpinus, within the west traces of the Indo-Afghan" [23] The Indo-Afghan is Risley's Indo-Aryan type, tall, dolicho brown, with thin prominent aquiline nose, long oval face, black eyes and black wavy hair. This race occupies regions south of the Pamirs and the Hindukush. The Irano-Pamirian type, as one descends down the slopes of the Hindukush, slowly merges in the Indo-Afghan type The high percentage of brown complexion among the Kaffirs proves the measure of admixture with the Indo-Afghan element

Guha's theory that the Kaffir is closely related to the Aral-Caspian type and is distinct in some measure from the Indo-Afghan type is obviously based on the percentage of straight nose and blondism among them. The percentage of straight nose is as follows Pathan 62, Red Kaffir 72, Kalash 70, Kho 79.[24] Of these the Pathans are Indo-Afghan, the Khos who have the highest percentage of straight noses are a brachycephalic people with C. I. 80·26. Among the Pathans with C. I 76, that is, less than the average cephalic index of the Kaffirs, and classed as Indo-Afghan it is not less than 62 As regards blondism it is only 15 per cent among the Kaffirs. Giuffrida-Ruggeri writes, "It is an established fact that here and there in Central Asia one finds blonds for which we have the authoritative testimony of Ujfalvy" and he gives Ujfalvy's figures showing that among the Galchas or Hill Tajiks the percentage of blonds is 8, among the Tajiks of Fergannah 12 to 13 and among the Tajiks of Samarkand upto 27 [25] The Tajiks regarded as descendants of the eastern Iranian race are a very brachycephalic people with C I as high as 83 14[26] (Giuffrida Ruggeri, 84 42) It appears that neither in regard to the percentage of straight nose nor in regard to blondism can the Kaffirs claim to hold a position which would distinguish them from the neighbouring tribes Referring to the Bashgali Kaffirs, Stein writes, "The anthropometric data I could collect were mainly of interest as proving the close affinity of these Kaffirs with the more civilized Dard tribes further east as already suggested by linguistic evidence Most of the refugees still adhere to their heathen creed, an inheritance probably from the days when the Dard tribes separated from the Iranian race "[27] Lastly, reference may be made to Joyce who writes, "Ujfalvy puts forward the theory that in pre-historic times the Iranians brachycephalic and brown-haired, settled on the banks of the Aralo-Caspian sea A certain number crossed the Pamirs and established themselves in the Tarim Basin "[28] According to Dr Guha's definition, brown hair is partial blondism, but doubt arises whether the head form of the Aral-Caspian type was dolichocephalic or brachycephalic It is noticed that among the Hindukush tribes closely related to the brachy. Irano-Pamirian type (C I 85, N I 62-72, stature 166-170, nose prominent, aquiline to straight) the prevailing tendency is to brachycephaly and, as one descends southwards, to mesaticephaly

To return to the Dharmarajika type, the Dharmarajika monastery of Taxila was sacked by the White Huns in the 5th century after Christ. The skeletal remains found there are supposed to have been those of monks residing there. These monks or inmates of the monastery were presumably Buddhist *sramans* temporarily living in the monastery, assembled there from different parts of the country, and included probably non-Indians because Taxila was an important seat of learning in the Buddhist world. The White Hun hordes burst upon northern India in

the middle of the 5th century when Skanda Gupta was on the throne of Pataliputra. Having recovered from their earlier defeat at the hands of that monarch, they renewed their attacks and occupied Gandhara about 465 A.D. and next pushed into the interior while the Gupta empire collapsed. Long before the Huna invasion India, particularly north-western India, had seen successive waves of foreign infiltration or invasion. Two centuries before Greek invasion, N. W. India, Sind and probably part of the Punjab east of the Indus were occupied by the Persians and formed part of the Indian satrapy. Greek invasion was followed by the extension of the Maurya empire up to the Hindukush. The Punjab or north-western part of it was held almost uninterruptedly by the Bactrian Greeks from the end of the Maurya empire upto the rise of the Parthian power under the Arsakidan dynasty. The Sakas had entered India in the meantime and by 50 B.C. foreign satrapies—probably Saka—were established at Taxila and Mathura, acknowledging allegiance to the Parthian monarch. The western Punjab was directly under the rule of Indo-Parthian dynasties. About the middle of 50 A.D. the Yuechi or Kushan king Wima Kadphises annexed the Punjab. Numismatic evidence testifies to renewed contact between N. W. India and Persia under the Sassanian dynasty. In the 5th century the last Kushan king of Kabul was overthrown by the White Huns.

The two great epics mention a number of foreign races settled in different parts of India. The *Ramayana* mentions among the northern tribes Daradas, Yavanas, and Sakas.[29] In another place the Chinas, Tukharas and Barbaras are mentioned along with the Kambojas.[30] In the Balakanda are mentioned the Pahlavas, Sakas and Yavanas.[31] The *Mahabharata* gives many lists of foreign tribes. The Pahlavas, Sakas, Yavanas, Chinas, Hunas, Khasas are mentioned as Mleccha tribes.[32] To the great Rajasuya sacrifice were invited the Pahlavas, Chinas, Yavanas, Hara-Hunas, Tusaras, Hunas, Daradas etc.[33] One list mentions Kshatriyas of Darada, Bahlika and Pahlava countries.[34] The Pahlavas, Yavanas and Sakas are mentioned as western tribes living by the sea.[35] In the *Santi Parva,* there is a list of tribes living under Brahmanical system, including Yavanas, Sakas, Chinas, Tusaras, Pahlavas etc. (Ch. 65). It is to be noted that these foreign tribes were apparently regarded as inhabitants of the country. They were called Mlecchas and Dasyus but the *Santi Parva* reference and the *Manu Samhita* reference (Sakas, Paradas, Pahlavas, Khasas, Chinas and Yavanas among degraded Kshatriyas (vv. 43, 44) show that they were regarded as Kṣatriyas who had deviated from the orthodox standard due to distance, lack of communication with Brahmans etc. This would mean that they had fully or partially accepted the Brahmanical religion and social system. These foreign tribes must have lived in India for a long time and largely intermingled with the indigenous population before this stage was reached. Reference may be made in this connection to the legend of Sagara who was persuaded to spare among others the Pahlavas, Sakas, Yavanas etc.[36]

The Hunas appear to have been the last of these foreign tribes coming to India. They are known in Indian history under the names of Mihiras and Maitrakas. There are a number of tribes who are held to have accompanied the Hunas or preceded or immediately followed them. These are the Jats, Gujars, Meds, Abhiras etc. The Jats are regarded as representatives of the Getae of the Greek and Roman writers. Todd and others have suggested Central Asian or "Scythian" origin of the Jats and Gujars. The Jats are traced from the Punjab to Sind, Baluchistan, Seistan, Iran, S. Afghanistan, and it has been pointed out that a tract of country beyond the Sihun (Jaxartes) was known by the name of Jatah as late as the 14th century. A Jat colony has been mentioned in Armenia about 3rd century A.D. in the work of Zenobius.[37] It is stated that the Varaich Jats who are all Moslems but observe many Hindu customs say that they came into India with Mahmud of Ghazni. The Jats have been associated for many centuries with the Med tribes in Makran. According to Tate, in the Abhils (Habhil, Abhil) of Seistan is found a fragment of the race which gave their name Abhiria to the northern coast of the Arabian sea.[38] It has been suggested that traces of the Abhiras are preserved in the Abisaras of Alexander's historians in Sabiria or Abhiria in upper Sind. Cunningham traces them to the Abaras of the Indo-Scythian race who in the 2nd century B.C. conquered the Punjab and Sind and were later defeated by the Yuechis.[39] The Gujars have been identified by some scholars with the Khazar or White Huna of the east Caspian coast and it has been suggested that they were identical with the people of Georgia whose Persian name is Gurjistan.[40] They are again held to be identical with or allied to the Gaudar tribes of cattle owners of the Seistan Hamun and Numrias of Sind. Among the Brahui tribes are the Nagris a known Gujar sub-division, Merwani (Meds), Mehrani (Mihiras) etc. It is stated that these names are probably traces of the passage of the Khazars or Gujars both by the Bamian and through Seistan and Afghanistan.[41] Cunningham traces them to the Yuechi or Tokhari[41a] An extreme view is represented by a scholar who holds that cattle-breeding, sun-worshipping Sakas were in India long before the so-called Aryan invasion[42] and the Abhiras identified with the Scythian Abaras entered Gujerat about 400 B.C.[43] The Gujars are again held to have entered India during the rule of Kaniska and the Jats are said to have come at the

same time.[44] It is suggested by St. Martin[45] that Jartika which seems to be used in the *Mahabharata* for as another name for Bahika is a Sanskritized form of Jat. It is added that the Jats were one of the leading tribes who about the beginning of the Christian era passed from Central Asia to India. It is suggested that a portion of the Yuechi entering India came to be known as Bahikas [46] The Mudgals are traced to the Sakas and the Paradas to the Parthians.[47]

It is not necessary to examine which of the views referred to above are correct, at any rate they show that races belonging probably to different ethnic stocks had established themselves in N W India and penetrated into the interior, long before the White Hun invasion, in the 5th century Dr Guha has assumed that the human remains of the inmates of the Dharmarajika monastery at Taxila of the 5th century may be taken as representing the Vedic Aryan type It is highly probable that the pre-historic Vedic Aryan type at a frontier station like Taxila must have been obliterated by successive hordes of northern invaders before the Epthalite Hunas broke loose from the Kabul Valley and swept through the northern gates of India To say the least, no pure racial type can be expected to have been preserved in N W India under the circumstances in the 5th century If the possibly very mixed Dharmarajika type is affiliated to the pre-historic Vedic Aryan type, it is to be presumed that the Vedic Aryan type was very mixed

Dr Guha has found four different racial strains among the Hindukush tribes, it has been found from the analysis of Joyce of the data of Stein and Ujfalvy that the predominant tendency among them is to brachycephaly The hypothetical Proto-Nordics were a dolicho people The assertion that the Proto-Nordic strain is to be found in its purest forms among the Hindukush tribes is unsupported by any evidence If the Dharmarajika type is affiliated, on the one hand, to the Vedic Aryans and, on the other, to the Hindukush tribes, the conclusion is that either the Vedic Aryans were mesaticephalic or brachycephalic or very mixed.

It has to be admitted that there is no anthropological evidence which would support the theory that the Vedic Aryans were Proto-Nordics The evidence of language does not support the theory Giuffrida Ruggeri points out, . . . "It is useless and vain to ask, who were the Aryans, the Dolichocephals or the Brachycephals The Aryan languages spread from a very northern centre, and that without any special regard for the brachycephals or the dolichocephals "[48]

We may now turn to the last evidence which goes against the theory, namely, the evidence of the *Rigveda*.

The primary basis of classification of the Rigvedic people that is found in the text is not ethnic as is supposed by some scholars. Classification is made from the point of view of the authors of the text, into ṛsis, their friends and their enemies. The ṛsis are the composers of the hymns, priests presiding at sacrifices, exponents of the Rigvedic culture, their friends are their open-handed yajamanas of the princely order; their enemies are non-performers of sacrifice and persons who do not follow their *vratas* and gods, and their rivals The priests belong to the well known ṛsi clans, the Angira, Atharvan, Kanva, Vasistha, Bharadvaja, Bhrigu, Atri, Kausika etc. The yajamanas being to the princely order, the well known Rigvedic tribes, the Tritsus, Bharatus, Purus, Anus, Turvasas, Druhyus, Yadus, Srinjayas etc. The enemies do not form a distinct social class, each ṛsi clan or each individual ṛsi has his own enemies, including members of the ṛsi clans and princely order A secondary division of peoples, not as extensive as the primary division, is into the Arya and the Dasa or Dasyu The basis of this division, according to the text, is cultural and not ethnic The difference between the Arya and the Dasyu was that the Arya was a performer of yajna while the Dasyu was an enemy of yajna and without *vrata* (Rv. I 51 8, 9) The Dasyus and Dasas are several times spoken of enemies of the Aryas and it might seem that they belonged to distinct racial groups but as, with a single exception (the Panis), no Dasa or Dasyu tribe is mentioned by name and as the individual Dasas and Dasyus appear to be all mythical persons, it can not be said that the distinction has any ethnic basis It has to be admitted that from the uses of the term Arya in different contexts in the Rigveda it is not possible to say that the term is consistently used in an ethnic sense This doubt is confirmed when it is found that king of the well known Yadu and Turvasa tribes are spoken of as Dasa (Rv. X. 62. 10).

The ṛsis call themselves Arya. Supposing that the term is used in ethnic sense it may be asked whether the Rigvedic tribes were not Aryas in the same sense? No yajamana tribe seems to be described as Arya though we find a reference to Arya *Yajamana* and another reference to two unfriendly Arya kings living on the banks of the Sarayu. If the view is taken that the ṛsi clans were racially different from the yajamana tribes—a view for which there seems to be some justification, then the theory that the Rigvedic Aryans conformed to a homogenous racial type is ruled out. If the view is taken that they belonged to the same racial type we find from the text that this type was very much mixed. There were dark-skinned ṛsis and fair-skinned ṛsis and dark-skinned yajamana tribes. A ṛsi of the

Angira family speaks of the fair-skinned friends of Indra (सखिभिः श्वित्न्येभिः). (Rv I 100 18) These fair friends were the Angiras. The Vasisthas were fair and they wore their hair in a braid on the right when they officiated at sacrifices श्वित्यंचो मा दक्षिणतस्कपर्दाः etc (Rv. VII 33) The Kanva family of ṛsis are spoken of as brown or medium complexioned. उत कण्वं नृषदः पुत्रमाहुरुत श्यावो etc (Rv X. 31. 11) The Kanvas are spoken of as brown in another place (Rv. VII 55 5) The Kanvas were the family priests of the Purus The famous Puru king Trasadasyu is described as the leader of the brown people (Rv VIII. 19, 37)

From the above it is found that the ancient ṛsi clans, the propagators of the Vedic culture in India, were a mixed people and the yajamana tribes, whether of the same ethnic stock or not, were also a mixed people Rama Prasad Chanda's theory is that the yajamana tribes or most of them were a dark or brown race originally belonging to the tropics (south-western Asia), who entered India after the fair ṛsi clans from the far north had settled down in India The existence of dark ṛsi clans—the Kanvas and Kausikas—is explained by him as being due to the fact that they were ṛsis or Brahmans by adoption and not by descent, that is, these two clans originally belonged to the princely order [49]

There is no room here for discussion of important issues raised by Chanda's theory What is clear from the evidence of the Rigveda is that the Vedic Aryans were of different physical types and, therefore, a mixed people. This is corroborated by anthropological evidence discussed above The theory that the Vedic Aryans were dolichocephalic Proto-Nordics is, therefore, without any basis The probability is that they were a mixed people Their affinities with the early Iranians represented by the brachycephalis Tajiks, Parsis and Pamirian tribes would suggest that they might have been brachycephalic.

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[34] *Ibid*, Sabha Parvan, Chs 50, 51

[35] *Ibid*, Chs 16, 17

[36] *Visnu Purana*, Ch 3

[37] *Journal of the Royal Asiatic Society, Bengal*, Vol V, p 331, 1836

[38] G P Tate, *Seistan*, Part IV (Calcutta, 1912), p 309

[39] Cunningham, *Archaelogical Report*, II, pp 23f

[40] Rawlinson, *Transactions of Royal Geog Society*, IX, 51

[41] J E Campbell, *Gaz Bomb*, XI, Part I, p 478

[41a] *Archaeological Report*, II, 64f

[42] *J R A S*, XXII, 332

[43] — - — XXI, p 11 Note

[44] *Bomb Pres Gaz*, Vol I, Part I, p 2

[45] *Geog greque et latine dans l'Inde*, quoted in *Bomb Pres Gaz*, Vol I, Part I, p 103 Note

[46] *Bomb Pres Gaz*, Vol I, Part I, p 105

[47] *Ibid*, Vol V, p 129, Note 4

[48] Giuffrida-Ruggeri, *op cit*, p 24

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SOIL EROSION IN THE DAMODAR BASIN

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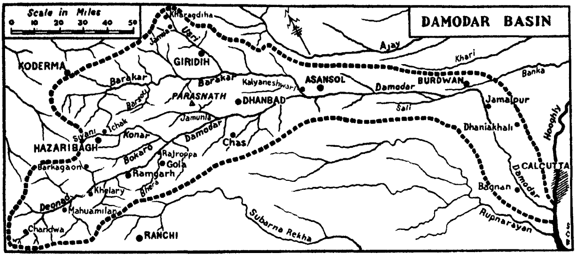
ONE of the chief causes of chronic floods in the Damodar River, aptly called the "Sorrow of Bengal", is the alarming condition and degree of soil erosion in its catchment basin, for run off after rains from an eroded surface is extraordinarily quick. Run off is as much a function of surface condition and its vegetational cover, as of the intensity of rainfall and slope. A survey of soil erosion, therefore, seems to be of primary importance for the success of the multipurpose scheme to harness and utilize the water resources of the Damodar Valley.

The evils of soil erosion are numerous. It rapidly lowers the fertility of the soil, for in residual plateau soils, only the top seven inches are of any use to plants, and once this layer is removed, the work of nature for a century or more, in preparing it from the bed rock, is lost. Ultimate gullying and complete removal of soil, till the bed rock is exposed, means permanent destruction of land from the point of view of utilization. Soil erosion leads to the lowering of stream beds and decrease in their dry weather flow, due to drying up of springs. This leads to a lowering of the water table and a consequent difficulty of the vegetable cover to procure water from the subsoil. Absence of sufficient vegetable cover makes the soil loose and helps quicker erosion. The vicious circle is thus completed. Loosened soils of eroded land are easily carried away by rain water due to excessive run off. Thus small streams become swollen torrents of silt laden water after rains. The over burden of silt, when it reaches the flat plains of Bengal, is quickly deposited. The bed of the Damodar is, therefore, steadily rising and the channels of its distributaries are being choked up. Thus soil erosion which, on the one hand, helps quick run off and increase in the volume of flood water, on the other hand decreases the carrying capacity of channels by choking them with silt. The inevitable result is disastrous floods.

Soil erosion is widespread in practically the whole of the Damodar Basin, except in the lower part in the plains of Bengal. The Upper Damodar Valley from Chandwa to Ramgarh, though fairly well covered by forest, is already showing signs of cracking up. The Damodar or Deonad, as it is called here, rises from five springs in Khamarpat, a table-topped hill, 3500 feet high and eight miles south of the railway station of Tori. Here, as at many other places, the forest is privately owned, and quick profit motive is leading to its rapid extermination. Inside the dark forest live Mundas who still practise primitive methods of cultivation. They make small clearings for cultivation by felling trees and setting fire to them, and they move from one patch to another. This has been a constant source of destruction of forests, but the depredations of civilized man have far exceeded the damage created by them. Besides felling trees for timber, pit props and so forth, young trees are mercilessly cut down to produce charcoal. This commodity is now much in demand, due to practically a universal use of charcoal in buses plying on the roads of Hazaribagh and Ranchi. According to a rough estimate, nearly 200 buses run 10,000 road miles daily in this area, consuming 500 maunds of charcoal every day. This means a colossal loss to the forest. Wisps of blue smoke curling upwards indicate the positions of numerous charcoal ovens, to be found every where in the jungles. Small bullock-carts, called chhakkars, having wheels of solid discs of *sal* wood, toil up and down the zig zag tracks to collect logs, firewood and charcoal. The magnitude of destruction is so much that hardly any tall trees have been left. From the lower edge of the escarpment running parallel to the Damodar south of it, to the edges of blocks of sandstone hills between the northern tributaries, soil is being scooped away right from underneath the young *sal* trees, which stand helplessly on small earth mounds, with their roots exposed, and in danger of being completely uprooted at any time. Small streams by accelerated lateral corrosion are attacking the loose soil on their banks, sometimes creating awe-inspiring soil cliffs. At places worst affected, deep yawning gullies, their red walls of lateritic soil contrasting with the green of the forest, are spreading and branching out. Some of them are more than 50 feet deep, and there seems but little chance of stopping them from spreading like wild fire. The only places where erosion is under some control are carefully cultivated and terraced paddy lands. The most conspicuous and soothing to the eye in this scene of destruction is the well cultivated plain of Mahua Milan.

Further down the valley around McCluskiegunj there is an Anglo-Indian colony, where many individuals have been spending large sums of money to build farms based on scientific methods. But they have only met with partial success. Soil erosion is one of their chief enemies, and perhaps scientific methods to fight this menace are not well known to them, and no collective effort has been made to this end.

Except for the Cement Works at Khelary, the lime kilns at Hendegir and the Railway Colliery at Bhurkunda, modern industry has not yet encroached upon the forest here. But with coal seams underneath, a major part of this area, sooner or later, will be opened up for industrial development. Care should be taken from now that this does not result in a total destruction of forest and cultivated land, as at Jharia.



From Bhurkunda to Ramgarh and the gorge of Bokaro at Dania, the land has been very badly cut up and gullied, and the forest cover is very thin. The colliery establishment of Argada has further helped in the destruction of natural cover.

Further down in the valley of a southern tributary named Bhera, only small patches of forest have been left here and there. One sees a series of vast red 'tanrs' or bare low swells of land which have been denuded of their fertile top soil by sheet erosion. But gullies are also there, being specially visible near the banks of streams, from where they work up into the 'tanr', eating away the cultivated lower portions, for the tops of these swells are covered only by thin grass, where continuous grazing gives the forest no chance to grow again. Another feature here are low hills covered only by scrub and attacked at their lower edges by gullies. At Gola the forest reappears, but it is very badly mutilated and cut up, there being more bushes and young plants than trees. The forest is deeper and erosion less intense only near the junction of the Bhera and the Damodar.

The Bokaro drains the southern part of the plateau of Hazaribagh. For the major part its catchment is covered by forest, and cultivation is only practised in patches. But the axe is as active here as at other places. Near the banks of some streams weird forms of soil mounds, ridges and pillars can be seen. This is specially so round about the town of Hazaribagh where soil is being removed injudiciously for brick making. Erosion gullies and brick kilns are seen side by side near the roads to Ramgarh and Barkagaon. To reach the latter place one has to pass through the upper Bokaro valley, where the condition of the forest is very similar to that at Torri, sal coppice being more prominent than giant noble trees. Beyond the plateau the road proceeds in a zig zag course down its precipitous edge and enters a belt of heavily eroded land before coming down into the rich green valley of Barkagaon. Even here gullies and soil cliffs are evident near paddy fields along the streams. Barkagaon lies on the Karanpura coal seams. Already there is a scheme to build a railway to it, and exploitation of coal is to begin sooner or later. Proper Government control will only save this fertile valley from being sacrificed on the altar of mineral exploitation. Mohudi and other flat-topped hills of sandstone beyond Barkagaon have huge talus slopes at their bases. They seem well covered by forest, and except for the collection of firewood and uncontrolled grazing, the axe has not inflicted the same degree of damage as elsewhere.

The middle part of the Hazaribagh plateau is drained towards the west by the affluents of Konar and Sivani. Careful cultivation is a feature of the upper parts of their valleys and as a consequence soil erosion is absent. But the devil is at the door, if he has not yet crossed the threshold. For on the road to Bagodar charcoal ovens on the roadside are a common sight, and the ubiquitous chakkars come out of the forest loaded with firewood and loped branches of trees. Erosion gullies are seen along the lower slopes of 'tanrs' and near stream banks. Kurthi, a kind of legume is very often cultivated on sloping lands, but the furrows, commonly, are

parallel to the sides of fields, and not level along the contours. Thus contour furrowing is unknown to the farmers. When perchance the furrows run down the slope, soil is washed out very easily after rains. The lower valley of Konar is covered with forest and erosion is less intense.

The Upper Barakar valley constitutes the northern part of Hazaribagh plateau. Very much near the source of Barakar near Ichak careful cultivation has kept the evil at bay. But between Ichak and Hazaribagh extensive gullying can be seen from the top of Canary Hill. Morabba, a kind of *sisal*, is being grown nearby round the lakes. The plant supplies fibre for convict workers of the district jail, who produce ropes, mats and many other articles from it. This plant can grow very easily on eroded and gullied lands, and may easily be tried as a cover plant to check soil erosion. Further down the Barakar valley there is more forest and less cultivation. But again sapplings are more in abundance than tall trees and lopping of branches for firewood continues.

Top left: Sonasathi, a spring, which is the source of Damodar. Beyond the gap is seen a forest clearing by Mundas, the trees being felled and put to fire. *Top right*: A hundred ft. soil cliff by the side of a stream near Tori, a result of accelerated lateral corrosion.
Middle left: Silted up Topchanchi water reservoir at the base of Parasnath hill. *Middle right*: The valley of Barkagaon. Note the erosion gullies among paddy fields by the side of the stream.
Bottom left: Road side erosion a few miles from Koderma on the road to Domchanch and Giridih.
Bottom right: Bare 'Tanr' land near Chas, where wind erosion is active. Note the gullies.

The Grand Trunk Road between Bagodar and Barhi runs along the foot of the escarpment forming the northern edge of Hazaribagh plateau. The whole zone between the road and the wall-like escarpment

is very badly cut up. In the catchment of Barsoti Nadi there are many bare 'tanrs' with eroded edges

Further down the Barakar Valley on the way to Koderma there are vast bare open fields where sheet erosion has made the whole area unfit for cultivation. Rock outcrops and boulders strewn all over the place give it the appearance of a stony waste Cultivation is only in patches The depressions in the land are also very badly cut up by gullies

Only north of the railway line conditions improve slightly in the neighbourhood of Kodarma, though here also bad lands abound Further down the Barakar passes through a densely forested and hilly area just north of the mass of Parasnath, where the forest is best preserved The northern slopes of Parasnath are covered by stately trees and dense undergrowth. Soil erosion is, therefore, absent In the upper basin of Usri well terraced paddy fields and carefully cultivated lands occur around Kharagdiha, but at places such as near the Usri bridge, erosion has destroyed previously terraced lands A particularly badly cut up depression occurs near Jamua. Near Giridih erosion is very common, and all its varied types can be seen Inside the colliery zone the edges of sandstone hills have been eroded into fantastic forms, best seen all round the Bhadoa hills At one place myriads of earth pillars with boulders resting on their tops stand silent witnesses of sheet erosion Trees with bare roots nearby corroborate the testimony

On the other side of Usri along the banks of a small tributary named Khandauli, some of the worst types of bad lands can be seen The giant gullies starting from the banks of Khandauli have spread into the 'tanr' covered by young sals for miles and has eaten away hundreds of acres of arable land

Here some attempts are being made to check this colossal destruction A well-to-do settler (a Bengalee farmer) has bought a large piece of eroded land He has planted orchards on the tanr He is experimenting with a special type of upland paddy which grows without irrigation. He is trying to stop gullies by cut-and-fill methods and also by building embankments across waists of large patterns of finger gullies. The same methods are being practised by some local farmers But their attempts seem to have started too late Modern methods of gully-plugging are unknown to them.

On the southern slopes of Parasnath the forest is even better protected. In the catchment area of Topchanchi water reservoir no grazing is allowed The dense natural vegetation cover is made denser by planting bamboos. Inspite of all these precautions much silt has found its way into the lake, which has lost 30 per cent of its original capacity. Water shortage is feared during 1946 due to lack of rains. It is unfortunate that bamboos worth over a lakh of rupees have been sold last year from this forest. This is sure to make conditions worse for Topchanchi

In the valley of Jamunia south of Parasnath erosion is noticed from the source to the point of confluence Very badly cut up lands occur near Bagodar on both sides of Jamunia In between conical forested hills erosion is specially marked near their bases and along the banks of streams flowing southwards.

In the Jharia coal fields one is confronted with utter destruction of land Not only has the 'robbery' of coal proceeded unchecked but the forest cover and arable land have also simultaneously vanished Among the wheels of lifts, chimneys, power houses and coolie quarters lie sunken wastes overgrown with weeds such as *ban-tulsi* and *akhaura*. The Bokaro field does not present such a scene of desolation yet Perhaps a better planned method of mining might save the land.

South of Jharia around Chas some *sal* coppice occurs here and there, but there are large bare tanrs again where wind erosion is quickly removing whatever has been left, by sheet and gully erosion Some very badly cut up lands occur in the swell of land which marks the southern boundary of the Damodar Basin West of this area between Petarbar and Gola some places have been reduced to a stony waste

Below Dhanbad the Damodar joins the Barakar and enters the District of Burdwan Even here gullies and sheet erosion are evident on swells of land which are covered by young sapplings and coppice The lower areas are, however, covered by level deposits of alluvium Beyond the town of Burdwan the flat alluvial plain is continuous and the problem is that of deposition, and not of erosion

Road-side erosion is another evil worth mentioning Injudicious supply of road metal from adjacent fields is its only cause—a cause which can easily be removed This type of erosion is very common and sometimes assumes serious proportions At some places cart tracks become avenues of attack, and are changed to sunken lanes from which gullies start sideways.

To summarize, soil erosion in the Damodar Basin occurs specially in the following situations

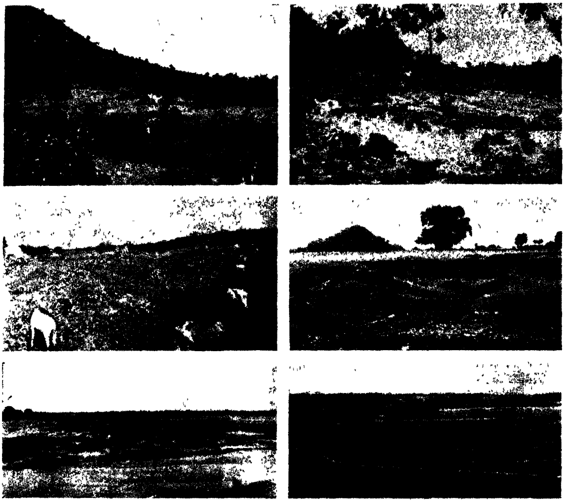
1. Lower slopes of isolated hills or escarpments,
2. Along the banks of streams, and spreading in transverse gullies from them ;
3. Along the edges of bare swells of land called tanrs ,
4. Sheet erosion on the tops of tanrs ;
5. Road-side erosion.

The main causes of this accelerated soil erosion are :

1. Deforestation for the sake of timber, fire wood, charcoal, and loped branches for fodder ;

2. Overgrazing and uncontrolled grazing. Goats are specially injurious ;
3. Careless methods of cultivation such as furrows running down the slopes, insufficient care of terraces, no proper rotation and use of cover crops ,
4. Lack of knowledge of easy methods of erosion control such as gully plugging, contour furrowing, contour strip cropping, proper terracing, construction of grassed diversion ditches, wind screens and so forth ;
5. Injudicious supply of road metal to roads ,
6. Uncontrolled methods of mining without any proper care to protect surface cultivation and vegetation cover.

It is abundantly clear that a complete control of soil erosion is a pre-requisite to prosperity and development of the Damodar Basin. This region is not only badly eroded, but also the ailment is of a progressive nature. If the value of land is not raised a costly project will not pay. Hence a great effort should be made to control this ever-increasing menace.



Top left Erosion at the base of a conical hill near Gomoh Note the mutilated forest and soil mounds
Top right Earth pillars with boulders on their tops and trees with exposed roots in Bhadoa Hills near Giridih
Middle left Grazing on eroded land near the slate river a few miles away from Giridih Note the soil cliff in the back ground *Middle right* Bad lands near Koderma
Bottom left Destroyed terraces on the banks of Usri near Kharagdiha *Bottom right* Patterns of finger gullies spreading out from the banks of Khandauli, a tributary of Usri.

The first and the foremost thing is the control

of forests and a scientific forest culture. Forest produce is necessary, but controlled "farming" of forests as practised in Sweden and Germany should substitute the haphazard mutilation of forest, for this purpose. The land should be divided into three categories according to its relief and present condition of soil cover, namely forest land, pasture, and cultivable land. Wherever the forest has been removed from the first category, afforestation should be immediately started.

As to the reclamation of already gullied lands—and there are many thousand acres of such land in the Damodar Basin—one might try the use of bulldozers and other mechanical equipment, as is being done in some parts of the Punjab. Dr R. Maclagan Gorrie who has done much useful work in the Punjab to check soil erosion is of opinion that the reclamation of land will pay the expenditure incurred. Reclamation is mechanically possible, and experiments will reveal whether the expense is justified.

Meanwhile demonstration centres should be opened to educate farmers in erosion control methods. A soil conservation research scheme is being worked at Shantiniketan, and this may serve as a model. Experiments in afforestation, turfing, contour bunding, gully closing and so forth, which are being conducted here, may prove to be of great value for erosion control in the Damodar Valley. Quick growing vegetation may be planted on eroded soils, to stop erosion. *Sisal* (Morabba) is perhaps a good suggestion for this purpose. It has, moreover, an economic use, and will give some cash return. For a part of the year *kurthi*, a kind of pulse, can be easily grown on eroded soils. Being leguminous it will make the soil rich. It can flourish on poor thin lateritic soils and even on sloping land.

Controlled grazing is of primary importance to check soil erosion and to give the forest a chance to re-establish itself. Special grazing grounds should be allocated where grazing should be allowed by rotation.

There are many administrative difficulties in carrying out the programme suggested above, but perhaps the setting up of a Damodar Valley Authority on the lines of T.V.A., with full power to develop and control land utilization in the best and most scientific manner, is a very good solution of the problem.

In the end it may be noted that the phenomenal success of T.V.A. was partly due to a complete control of soil erosion there. Let us hope that it will be possible to have the same degree of soil erosion control in the Damodar Basin.

THE BETATRON

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THE successful design of an induction accelerator for beta-particles, known as the betatron, opens up a new field of research in an energy region which could not be reached so far. The super-structure of the design was completed by Dr D. W. Kerst, of the University of Illinois, in 1940, over the foundations laid by Wideroe in Germany, in 1928 and by Walton in England in 1929. The first outcome of Dr Kerst's experiments was an induction accelerator which could produce 2·3 Mev beta-rays, using a varying magnetic field in an arrangement somewhat similar to that of the cyclotron. Next he constructed another accelerator—a much improved one—which can impart 20 Mev to electrons. Lastly, this was followed by the 100 Mev betatron, installed in the General Electric Research Laboratory and designed by W. F. Westendrop and Dr E. E. Charlton, of the G. E. Research Staff, who were associates of Dr Kerst in the construction of the 20 Mev betatron.

Theoretical Background

The fundamental electro-dynamical equation

$$\text{Curl } E = -\frac{B}{C}$$

suggests that an induced electric field is always associated with a time-varying magnetic field and that this field may be utilized in accelerating a beam of electrons rotating in that field and in enabling them to gain energy continuously. The principle is analogous to an ordinary transformer, where a host of revolving electrons form the secondary windings. In each revolution the electron will acquire the same voltage increase that would develop per turn of the secondary coil. If the electron performs '*n*' revolutions, the total voltage gain will be the same as developed across a secondary of '*n*' turns, placed in the same varying field.

This is a very attractive possibility because

(a) the same magnetic field can be utilized in bending the electron paths into circular trajectories and in accelerating them, while the magnetic field is varying with time. It, thus, suggests the possibility of eliminating the R. F. voltage used in the cyclotron for accelerating ions, rotating in a constant magnetic field.

(b) The very high velocity of electrons (2.61×10^{10}cm/sec for 5 Mev) makes it possible for them to acquire tremendously high energy within a very short interval, during which the magnetic field is varying. Normally, within a quarter period of a 60 cycles per sec., the electrons cover a distance of the order of 100 miles. This means a very large number of revolutions. In the 100 Mev betatron, the magnet is energized with 60 c/s a.c. power. During the first quarter of the cycle, i.e., $\frac{1}{240}$ sec., the electrons perform 250,000 revolutions, which is about 800 miles.

(c) Because of very low momentum, the values of the magnetic field H, and the radius r of the orbit of revolution, required to impart sufficient energy to the electrons, are well within practical limits. The radius of the electron orbit of the 100 Mev betatron is only 33 inches and the value of H is about 4000 gauss. The corresponding value of Hr for heavy charged particles will be much higher, and an accelerator, designed for heavy particles, will require an abnormally large vacuum chamber even when the maximum possible value of H has been considered.

The design of an induction accelerator, on the basis of the above suggestions, depends vitally upon a number of conditions to be satisfied.

(i) Whether the electrons may be made to revolve in a fixed orbit, while gaining energy in a time-varying magnetic field.
(ii) Whether there exist forces which will focuss the beam in such definite orbits, against defocussing factors.
(iii) Whether the disturbances arising out of scattering, relatively increase of mass and such others as may arise can be either eliminated or minimized upto the working possibility.

It was in 1928 that Wideroe in Germany theoretically showed the existence of a stable orbit for electrons moving in a time-varying magnetic field. He calculated that the flux Φ within any orbit is always equal to $2\pi r^2 H$, in a varying field, where r is the radius of the orbit and H is the field at the orbit. If now Φ and H vary proportionately with time, r remains constant. This flux condition was independently obtained by E. T. S. Walton, in Britain in 1929 at the suggestion of Lord Rutherford.

The stable or the equilibrium orbit condition can at once be arrived at in the following way.

An electron in a radially symmetrical magnetic field will move in a circle given by —

$$p = \frac{eHr}{c} \qquad \ldots \qquad (1)$$

where p is the momentum, e the charge of the electron and r the radius of the electron orbit, H the field at the orbit, and c the velocity of light.

If the magnetic flux enclosed at the orbit changes, a tangential electric field will be produced at the orbit given by

$$E_\phi = \Phi/2\pi rc$$

This will accelerate the electron. If now, the magnetic field is so adjusted that H and p change proportionately, the radius of the orbit remains unchanged (Fig. 1).

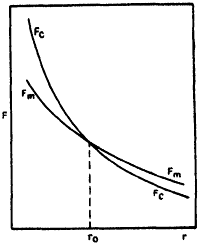


FIG. 1. F_c is the centripetal force, mv^2/r necessary to hold a particle in a circle of radius r. F_m is the magnetic force supplied by the field. The oscillations occur about r.

The electrons continue to move about the equilibrium orbit, though their momenta continuously increase with the increase of H. The rate of change of momentum is given by

$$\dot{p} = \frac{e\dot{\Phi}}{2\pi r_0 c} \qquad \ldots \qquad (2)$$

where r_0 is the radius of the equilibrium orbit. On integration we get,

$$p = e(\Phi - \Phi_0)/2\pi r_0 c \qquad \ldots \qquad (3)$$

Substituting for p from (1) and using r_0 for r, we have

$$H = (\Phi - \Phi_0)/2\pi r_0^2 \qquad \ldots \qquad (4)$$

Equation (4) indicates the condition of a stable orbit, viz., the change in flux through the orbit must be twice that would have been obtained if the

magnetic field were uniform in space. Thus, if a specially designed magnet satisfies the flux condition given by (4), then p will vary proportionately with H in that field, and according to equation (1), all the electrons, no matter what their velocities may be, will revolve along the fixed equilibrium orbit, gaining energy continuously as they revolve

After the establishment of the equilibrium-orbit condition, comes the question of axial stability This was the problem of whether the electrons, when scattered by the residual gas atoms, would come back to their stable orbit, under the influence of some focussing force or would be defocussed more and more and would be lost ultimately Walton showed, theoretically, the existence of a focussing force in the plane of the orbit, which would direct the deviated paths towards the equilibrium orbit, the electrons oscillating under that force The next question was whether the focussing oscillation would be a damped one, in which case the scattered electrons will ultimately form a well-defined beam , or whether the electrons would oscillate with increasing amplitudes and would finally be lost on the walls This was a very important question, because the electron path in such cases is of the order of 100 miles In 1940, Dr Kerst, following a detailed mathematical analysis, showed that such oscillations would be damped. His analysis clearly indicated the influence of the various forces on an well-defined beam and the mode of formation of such a beam out of a host of electrons injected from some source

The failures of the earlier experiments and designs of such an accelerator were due to the insufficient information regarding conditions of focussing and its dependence upon the mode and energy of injection of electrons into the varying field

Considering the radial focussing, *i e* , the motion of the electrons in the plane of the orbit, it is seen that the stable orbit condition is the condition for balancing the centrifugal and the magnetic forces When the electron is deviated from the equilibrium orbit in either ways, an unbalanced force will act Since the centrifugal force is proportional to $1/r$, this force will be directed towards the equilibrium orbit provided the magnetic field is less than this, or in other words, it falls off less rapidly than $1/r$. When displaced, the electrons will oscillate about their instantaneous circles, the frequency of oscillation being given by

$$w_r = \Omega\,(1-n)^{1/2} \qquad \ldots \qquad \ldots \qquad (5)$$

where Ω is the angular velocity of the electron in its orbit and w_r is 2π times the radial focussing frequency. The number n is determined by the radial dependence of H, *i.e.*, $H \sim [1/r]^n$; and for radial focussing n must be less than unity.

There is also the axial focussing force which would direct the deviated beam into the orbital plane. This gives rise to oscillations perpendicular to this plane, having frequency given by

$$w_A = \Omega n^{1/2} \qquad . \qquad .. \qquad (6)$$

For axial stability, n must be greater than zero. The value of n determines the cross-sectional area of the beam The axial focussing is present in the cyclotron and arises out of the curvature of the magnetic field about its median plane The curvature of the magnetic field gives rise to a vertical force on the revolving electrons This force increases with the distance from the median plane, being zero at the median plane and is always directed towards this plane

The axial and radial oscillations are both damped because the restoring forces increase with the increase of the magnetic field For non-relativistic velocities the damping is

$$\frac{da}{a} = \frac{dE}{E} \qquad . \qquad . \qquad (7)$$

where dE/E is the relative increase of the K E of an electron and da/a is the corresponding relative decrease in amplitude of the oscillation about the instantaneous circle This holds for both the axial and radial oscillations When the instantaneous circles do not coincide with the equilibrium orbit, they will shrink or expand towards it according to the following relation

$$\frac{dr}{r} = -\frac{dE}{E} \qquad .. \qquad .. \qquad .. \qquad (8)$$

where x is the displacement of the orbit from the equilibrium orbit and dx is shift of the orbit towards the equilibrium orbit for the fractional energy increase dE/E

From (7) & (8) it is seen that the focussing is more effective at smaller velocities It is also at this velocity that the scattering and space charge disturbances are most important The focussing is thus mostly completed during the few earlier revolutions and the instantaneous circles coincide with the equilibrium orbit—the major portion of the shifting taking place in the first revolution, after which the oscillations are greatly damped These are illustrated in the graphs represented in fig 2

Quick damping of the focussing oscillations and rapid shrinking or expansion of the instantaneous circles to coincide with the equilibrium orbit, allow the electron injector to be placed near the equilibrium orbit. Electrons injected from such a point, tangential to the orbit, will have their instantaneous circles bigger or smaller than the equilibrium orbit. During the first revolution these instantaneous circles are shifted enough towards the equilibrium orbit so as not to collide with the electron gun. Further, the

greater focussing and shifting of the instantaneous circles, during low velocities, allow a divergent beam of electrons to be injected It has been shown by Dr Kerst that if electrons are projected very near the equilibrium orbit, the focussing forces will be effective on all the electrons coming as a divergent beam This greatly increases the beam intensity The instantaneous circles of the injected electrons, being bigger and smaller than the equilibrium orbit, the flux within these circles is different from that required by the equilibrium orbit condition The orbits are unstable because momenta and magnetic field H are not balanced The circles shift towards the equilibrium orbit under the influence of the unbalanced force, the shifting being faster for smaller velocities

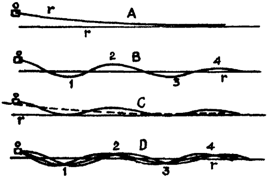


FIG 2 The figures represent the developed paths of electron r_0 is the position of the equilibrium orbit, and r_1 is the position of the instantaneous circle The injector is at O (A) Path of an electron injected tangentially on its instantaneous circle It approaches r_0 without oscillation (B) Path of an electron with an instantaneous circle coincident with the equilibrium orbit Oscillation occurs about r_0 (C) Path of an electron whose instantaneous circle does not pass through O at the time of injection but is between O and r_0 The oscillation is about r_1 while r_1 approaches r_0 (D) A real beam from the injector showing image formation at 1, 2, 3 and 4 The instantaneous circle is coincident with the equilibrium orbit

For injection of electrons two conditions must be satisfied First, the electrons should be injected at an energy, high enough, so that the injected beam may not be destroyed by scattering before reaching the magnetic field or during the first few revolutions. In a very rapidly increasing field, the electrons quickly gain energy and the scattering is not so important For slowly rising magnetic field it plays a predominant part Secondly, injection must be so performed that the electrons do not immediately fly out of the magnetic field In the case of slowly rising field, the field is practically constant for the first few revolutions of the electrons and since the trajectory in a constant magnetic field is symmetrical about a point where $r=o$, the electrons will fly out of the magnetic field if it is started from outside It was due to this fact that the external source in the case of some of the earlier designs proved to be useless

Since the instantaneous circles will exist only for a very small interval, while the field is increasing, a finite amount of charge only will be captured within orbits not striking the walls With a constant accelerating potential on the injector, the electrons first would hit the outer wall of the chamber before the magnetic field has grown large enough to give the electrons a curvature less than the outer wall Then as the field increases, the electron trajectories will get greater and greater curvature until they revolve inside the chamber Beyond that value, the electrons will be circulating in narrower spirals and ultimately strike the inner wall Only those electrons that get proper curvature of their paths and are circulating inside the chamber will be useful Thus out of a continuous supply of electrons only a spurt will be captured in the equilibrium orbit, within a certain fraction of the magnetic variation cycle In the 2 3 Mev betatron where 600 c/s was used, electrons were injected continuously at 200 v accelerating potential But in the subsequent high-power betatrons, it was found that if electrons were injected continuously at a fixed potential the beam was lost It was due to interference of the beam-electrons with those that entered the chamber at a later stage, when the field had increased high enough to spiral down the trajectories. Also the electrons that entered too early, and collided with the outer walls produced gas from the walls, enhancing the scattering disturbance Consequently the injection voltage was also made periodic and it was so co-ordinated with the main a c cycle that the injection voltage could be applied at the desired phase and could be made to last for a desired interval This arrangement admits electrons in such a spurt, having the accelerating voltage continuously increasing within chosen limits, that all the electrons are captured and there is no interference or gassing

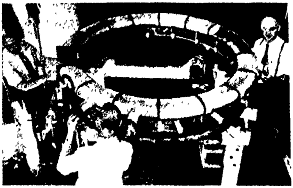
After the electrons have been captured and allowed to rotate in the magnetic field as long as it was varying, by some mechanism the flux condition is destroyed and the orbit gradually either shrinks or expands according as H or p predominates. Thus the beam may be made to collide with a target placed at a convenient position inside or outside the equilibrium orbit High energy electrons on striking the target give rise to high energy X-rays The methods of either shrinking or expanding the orbit will be discussed later on.

EARLIER ATTEMPTS

The first induction accelerator was designed by J. Slepian in 1922 , this was again modified by himself later on. His original idea was to allow

electrons from some source to spiral inwards in a varying magnetic field, under the electrostatic pull of a distant electrode. But as this would impart little energy to the spiraling electrons, he thought of using two superimposed magnetic fields—one static for bending the beam, the other varying with time for accelerating the electrons in the beam. But the "flux condition" could not be satisfied and the attempts did not show any prospect.

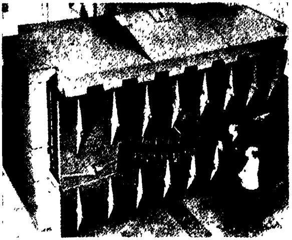
Later, Breit and Tuve, as a result of intense investigation of various modes of producing high energy particles for nuclear bombardment, designed an induction accelerator entirely different from Slepian's suggestions. They placed the chamber between a pair of large air solenoids, through which a high voltage condenser is discharged. This produced a very rapidly varying magnetic field. The electrons were projected from a gun outside the field. The electrons were to spiral inwards, where they collided with a target, placed at the centre of the chamber. In their arrangement the axial



The heart of the machine is this dough-nut-shaped vacuum tube of glass. The dough-nut has an over-all diameter of 74 inches, while the elliptical tube itself measures eight inches horizontally and five inches vertically.

stability condition was satisfied with the proper shaping of the solenoids. The injection method of Breit and Tuve was successful in accordance with the discussions already made in connection with the method of injection, because the field was very rapidly increasing.

The next useful development was made by Wideroe. He theoretically worked out the stable orbit condition. His method was to link the electron orbit with the leg of an iron core transformer, which contained an air gap in the plane of the orbit. The electrons travelled in a magnetic field generated by the same coil which sent flux through the transformer leg, and this field thus increased in strength along with the magnetic flux linking the orbit. This satisfied the flux condition, theoretically arrived at by him, for the existence of a stable orbit. Thus the electrons were prevented from spiraling inwards, and the additional central flux linkage supplied energy to the electrons. Wideroe, however, did not consider the focussing conditions, either axial or radial, and his mode of injection from outside was also open to objection, as the rate of growth of the magnetic field was very slow. Wideroe used two extra coils for destroying the flux condition at the end of the accelerating period, when the orbit would expand and the beam would be incident upon a target. But as he used to get his varying field by switching on D.C. power to the coils the field was very slowly varying and the beam used to get defocussed, while expanding, due to lack of a proper synchronization of the main magnetic field and the orbit-expanding field. Thus, X-rays were produced from everywhere due to the collision of the scattered high energy electrons with the walls. This again gave rise to



This machine will speed electrons to energies of 100,000,000 volts and produce X-rays of the same power. Dr. E. E. Charlton, left, and W. F. Westendrop are the two scientists at General Electric who have been responsible for the design and construction of this new super X-ray machine.

enough space charge and would interfere with the normal functioning of the apparatus.

Simultaneously with Wideroe, Walton also theoretically arrived at the stable orbit condition and designed an accelerator to substantiate his theoretical findings. He used a high frequency magnetic field and a hot filament source, inside the chamber. The filament source was the weakest point in his design.

There were two other designs by Steenbeck and Penny in 1937 and 1940 respectively. The former was an apparatus of Wideroe type, with a filament source and some improved arrangement for orbit expansion. The second design probably never materialized.

Betatron—The Apparatus

After analyzing the different focussing conditions and the proper mode of electron injection, Dr Kerst built an apparatus capable of energizing electrons upto 2 3 Mev

The magnet, made out of 003 inch silicon steel laminations, had the shape of a cyclotron magnet when clamped together rigidly The laminations were clamped by means of transite or asbestos rings, with cement of water glass and flint dust between the laminations for insulation Each pole-piece was capped by a disk of radially arranged laminations to achieve perfect circular symmetry The required flux condition was obtained by cementing two disks, about 2 inches in diameter, made of pressed iron dust (permeability $\mu=8$ C G S units), on to the centre of the flat pole faces The thickness of the disks was adjusted to satisfy the required flux condition at an orbit 7 5 cm in diameter This was to be the equilibrium orbit, the final adjustment of which was made by painting a mixture of water glass and iron filings on the surface of these disks Since the iron filings in these disks are separated, the flux density is greater here than the average flux density.

Because of high leakage flux the main coils were highly subdivided by using a cable of 200 strands Two coils of 10 turns, with nearly 10 yds cable in each, were made with $1/32''$ insulation between turns The coils were wrapped with cotton tape dipped in bakelite varnish and baked Eighty Pyranol condensers, each of $5\mu f$, 600 volt a c. working, were connected with the coils forming a resonating circuit Power was supplied by a two turn primary round the pole pieces from a 600 cycles per second alternator, rated at 4 k w and driven by a D C motor with adjustable speed (fig 3)

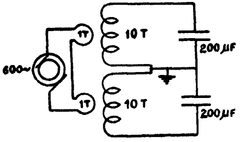


Fig 3 The resonant circuit which energizes the magnet Losses are supplied by a 4-kilowatt 600-cycle-per-second generator

The vacuum chamber was a hollow glass vessel of the shape of an anchor ring It was shaped by flattening a spherical glass bulb in such a way that the top and bottom of the central part, about 7 cm in diameter, stuck together and fused, which was subsequently scoped out, giving the whole thing the shape of an anchor-ring or a dough-nut The inner and outer diameters were 7 cm. and 20 cm. respectively This chamber was inserted in between the two pole pieces by lifting the upper pole together with the yoke The inside wall of the glass chamber was silvered chemically and the silver coating was grounded to eliminate space charge

The electron gun was a structure, similar in construction to an electronic tube, where the filament, the two focussing electrodes and the accelerating electrode were all introduced through a pinch glass seal The whole structure was sealed on to the vacuum chamber radially in such a way that the accelerating electrode was near to the stable orbit Electrons, issued out of this gun tangentially to the orbit, with initial accelerating potential varying from 200 to 600 volts Figure 4 shows the diagrammatic view of the electron gun

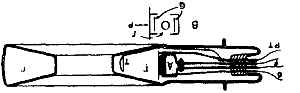


Fig 4 Cross section of the doughnut-shaped acceleration chamber The equilibrium orbit is at r_0, T is the tungsten-target, A is the injector, B is a top view of the injector A ribbon beam of electrons from the filament F is shot out through slots in the positive plates P G are negative focussing electrodes

The iron-dust in the disks, by virtue of their high permeability, become saturated when the field has grown upto a certain value, after which the flux condition is no longer satisfied due to saturation and the orbit shrinks inwards, where it meets a target, placed opposite the electron gun Thus, at a definite point in the magnetic variation cycle the orbit will automatically shrink

The magnetic field was throughly charted with a search coil , the e m f of this coil was balanced against the e m f from a voltage divider connected across an one-turn coil about the leg of the magnet. The pole faces gave a field, following a $[1/r]^{\frac{3}{4}}$ law, between radii 4 5 cm to 9 25 cm when the separation between the flat central portions of the pole faces was 2 8 cm. At $r=10$ cm., the variation was as $1/r$

The operation of this accelerator is not sensitive to alignment of the pole-pieces and vacuum requirements are not so severe as was expected.

The 20 Mev Betatron

The magnet is about 3 ft. high, 3 ft. wide, 5 ft. long and weighs approximately 3·5 tons The magnet is made out of 014 inch high grade silicon steel laminations, stuck together by means of thermo-

setting resin. There are air holes in the structure and air blast is used for cooling (Fig. 5). The flux required to maintain the equilibrium orbit at 19 cm radius is obtained by two radially laminated disks, the separation of which determines the shape of the field where separation is small, and the thickness of the disks determines the size of the orbit. The proper shape was first obtained on a model. The field follows a $[1/r]^{3/4}$ law between radii 18 cm and 20 cm. The graph in fig. 6 shows the typical H r variation.

Coil boxes made of Textolite contain 81 turns of a cable composed of 27 strands of .054 inch wire twisted together. .005 inch glass tape is used to insulate adjacent layers. Two such cables were wound in parallel in each box, the two coils being connected in series. The voltage on these total 162 turns is 16,500 r.m.s. volts and the current is 106 r.m.s. amperes at 180 cycles per second. The condenser bank, in series with the coils, forming a resonating circuit, has a capacity of 5.5 μf and handles 1750 Kv. at 20 Mev. The capacitors are water cooled.

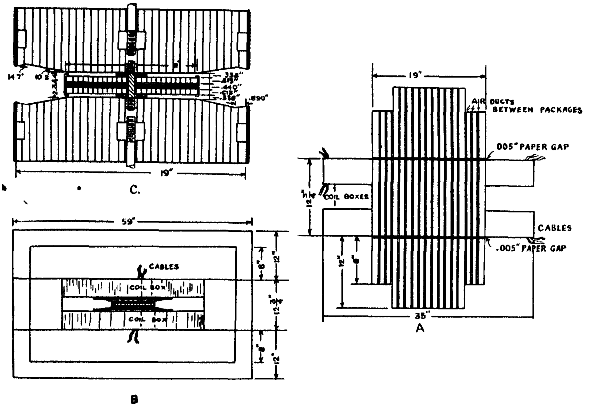


FIG. 5. A, B, C, the magnetic circuit. A is an end view of the magnet. B is a front view. C shows the details of the air gap. The shaded material is non-conducting. Laminations of different lengths form sectors which build up a circular pole.

A six turn primary, about the coil boxes and connected to a 700 volt static frequency tripler, supplies the power to the resonating circuit. Three separate transformers are run nearly at saturation flux density. Primaries are connected in "W" to the three phases and secondaries are connected in

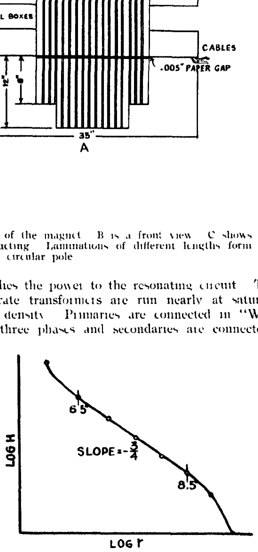


FIG. 6. Variation of magnetic field with radial position. The magnetic field can produce both radial and axial focussing where the slope is algebraically greater than −1.

series This arrangement cancels out the triple frequency voltage at the primary and 60 cycle voltage at the secondary.

The vacuum chamber has the usual dough-nut shape and was made out of two very short glass cylinders of radii $6\frac{3}{16}''$ and $8\frac{1}{4}''$, placed concentrically and waxing them with two flat glass washers Through holes in the outer cylinder were introduced the electron gun and the vacuum line. The inner wall was silvered and earth connected to avoid space charge troubles The chamber is placed in between the pole pieces

It was observed in the 2 3 Mev apparatus that whenever a current escapes from the injector into the vacuum chamber late in the acceleration period, the yield either decreased or disappeared The incoming beam moves in very minute spirals when the field has grown very high, and if this current is large enough, it can vitally interfere with the beam of high energy electrons Although it was not found essential either to stop injection after 1/12th of the cycle is past, or to use extremely brief injection period to avoid gassing, it was found useful to excite the filament gun periodically Keeping the voltage of the accelerating electrode constant, the filament voltage is co-ordinated with the main 180 cycle This produces a voltage wave depending upon the leakage reluctance of a r f transformer and the distributed capacity of the circuit Timing of injection is accomplished by triggering a thyratron from a coil on a thin strip of Permalloy (Ferro magnetic material) which bridges the magnet gap outside the equilibrium orbit. This strip is saturated most of the times, so that it produces a triggering just when the main field passes through zero The necessary shift in timing is produced by a flux biasing arrangement from an adjustable direct current through another coil on the same strip (Fig 7)

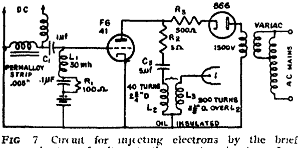


FIG 7 *Circuit for injecting electrons by the brief application of voltage to the injector structure, I*

At the point of the cycle, when the electrons have acquired the desired energy, a condenser is automatically discharged through two coils of wire, one directly above and the other below the equilibrium orbit The current through these coils adds flux within the orbit and the flux condition is destroyed The beam spirals away from the fixed orbit and finally is stopped by the target This method is superior to that adopted in the 2 3 Mev apparatus, because in this arrangement the electrons may be made to strike the target at any desired phase of the accelerating cycle In the 20 Mev apparatus, the target was fixed at the back of the injector To allow the electrons to move out in larger radii, the field should fall off more rapidly so that the centrifugal force may gain over that arising out of H It is necessary, therefore, to connect the two coils, reversely in series with two other coils, located at a much larger radius These coils must have fewer turns than the expansion coils, otherwise they will overcome the increase in the central flux by the expansion coils The expansion coils are of two turns each and the reverse coils of one turn each The expansion coils and the reversing coils being excited together, no flux flows through the iron Current from the frequency tripler in the primary circuit is used in a phase shifting circuit, which drives a peaking transformer The transformer contains a thin strip of iron with a secondary about it The strip remains saturated except when the flux through it is reversing, and at this stage, an abrupt voltage pulse is generated This voltage pulse triggers a thyratron which in turn starts discharge in an ignitron thereby discharging the condenser through the expansion and reversing coils By adjusting the resistance R_4, in the phase shifting circuit, the beam can be expanded at any energy below the maximum (Fig 8)

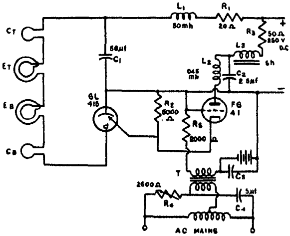


FIG. 8 Orbit expansion circuit CT, top compensating coil, CB, bottom compensating coil, ET, top expansion coil, EB, bottom expansion coil

This combination of the coils may be used also in correcting the shape of the field during electron injection so that the focussing forces may be fully utilized. The spurious magnetic fields set up by the

loss of current in the resonating circuit is large at the phase when the electrons are injected. Consequently, the correction in the shape of the field at this phase will be of very great importance.

The sequence of different operations are shown in the Fig. 9.

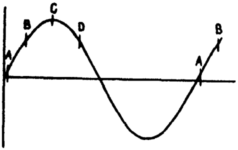


FIG. 9. The magnetic field as a function of time. Injection occurs at A, and the orbit is expanded at C to obtain maximum energy. If the expansion is done at B or D, the electrons will not strike the target with the maximum energy.

The position of the equilibrium orbit with respect to the pole faces of the magnet was found by the method of finding the radial position of the minimum electric field (c.f. flux condition). A system of concentric coils of fine wire was carefully wound on a flat circular disk of some hard insulating material. The radii of these coils were so chosen that each coil used the same length of wire and had one turn more than the next larger one. The disk, with this system of coils, was placed between the pole faces. The coil with minimum voltage was found, after joining reversely the adjacent pair of coils in series and determining the sign of the remaining voltage. The equilibrium orbit corresponds the turns with minimum voltage.

100 Mev Betatron

The magnet is of the usual shell type, made out of .014 inch 4.5 per cent silicon steel laminations. A number of laminations are stuck together with a solvent-less varnish which polymarizes on baking to form a slab or sector. The slabs, 7 inches thick, are spaced apart by means of narrow strips of wood so that air blast can force through these spacing for efficient cooling. Texolite rings were used for clamping the slabs forming the pole pieces. 1/16 inch thick pressbroad separates each pole piece from the yoke for insulation. The yokes are similarly insulated from the side pieces. The shape of the pole faces was determined on 1/8 and 1/4 scale models of solid piece and with D.C. excitation. The shape was so chosen that the magnetic field intensity, in the plane midway between the two pole faces, varied inversely as 3/4 power of the radius. This relationship assures a focussing of the electrons, after the first revolution, to a narrow beam most of which pass by the electron gun.

Two centre-piece disks were used as extensions of the pole faces to satisfy the required flux condition.

The magnetizing current is distributed over 80 turns of cable, 40 in the top and 40 in the bottom coil. The voltage per turn is about 600 V at 100 Mev and the reactive volt-amperes amount to 24,000 kva. This power is supplied at 24,000 volts r.m.s. from a capacitor bank, located in an upstair room. This capacitor bank balances the high inductive load, and this resonating circuit brings down the power factor by unity. The 24,000 resonant voltage is distributed at 600 volt per turn and 6,000 volts per layer. This requires careful insulation. Four layers of varnished cambric provided the insulation for 600 volt between turns and 1/4 inch Textolite blocks separated each layer. The capacitor bank dissipates about 80 k.w. and this represents a power factor of 1/3 of 1%. The iron losses are about 100 k.w. and both the magnet and the capacitor bank are efficiently cooled by air blast.

To prevent the loud sound (intensity 120-130 db.), produced due to the vibration of 130 tons structure, rubber supports are provided for the entire magnet structure as also for the glass chamber.

The dough-nut shaped vacuum chamber is constructed with 16 sectors of moulded pyrex glass, having an elliptical cross-section. These are joined together by means of red Glyptal. The over-all diameter is about 74 inches and the inside diameter is 58 inches. The equilibrium orbit is at a radius of 33 inches and it was found by balancing the flux through a one-turn coil of 66 inch diameter, with that through a pair of coils of 1000 turn of effective diameter $66/\sqrt{1000}$ inch. The electron gun, the target, and the vacuum line are joined to the torroid vessel through holes in three different sectors.

The electrons are injected at a velocity produced by 50-70 kv accelerating potential in the form of a voltage wave. The method of injection as well as the orbit expansion are similar to those used in the 20 Mev apparatus.

A tungsten wire target is mounted in the glass torroid at a radial distance 2¾ inch smaller than the equilibrium orbit.

The terigger and phase shifting circuits were as in the 20 Mev apparatus.

The electrical circuits of this apparatus require careful balancing, because a slight change in frequency—about 1/10 of a cycle—will cause de-

tuning of the resonant circuit, producing either lagging or leading of the current

The apparatus was housed in a special building with 3 ft concrete walls and a 1 inch motor-operated steel door The whole operations can be carried out from an adjoining room

Experimental Results

Absorption curves for steel and lead for various X-ray energies, produced from the 100 Mev betatron, are shown in the figures below (Figs 10, 11)

The X-ray out put at 100 Mev operation, as measured with a victoreen 100 *R* thimble chamber, placed within a ¼ inch lead jacket, at a distance of 550 cm from the target and computed to the standard 100 cm target-thimble distance, amounted to 2600 Rontgens per minute

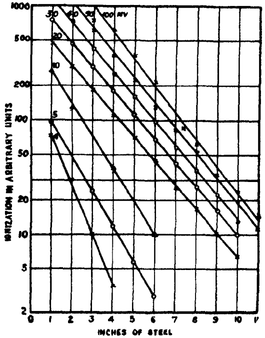


FIG 10 X-ray transmission through steel Ordinates in arbitrary units of intensity without relation between curves 100—, 50—, 40—, 30—, 20—, and 10—, megavolts X-ray curves taken with direct reading ionisation chamber Five and four megavolt curves taken with fluorescent screen and photo-multiplier tube

According to calculations, the mass of the electrons at 100 Mev is about 200 times their rest mass At this stage the radiation loss of energy becomes pronounced and put the practical limit on the time during which the electrons may be rotated The exact mechanism of the loss of energy is still a matter of controversy and remains to be studied thoroughly Cloud chamber experiments show the existence of particles having widely varying velocities A number of unusual and rare events, including the production of electron pair, have been observed In the path of the beam, all substances become radio-active due to the formation of unstable isotopes These subsequently transmute, producing alpha, beta and gamma radiations

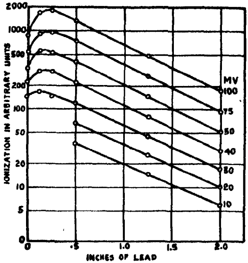


FIG 11 X-ray transmission through lead Ordinates in arbitrary units of intensity without relation between curves 100—, 75—, 50—, 40—, 30—, 20—, and 10—, megavolts X-ray curves taken with direct reading ionisation chamber

Proper explanation and verification of the peculiar and unusual phenomena occurring in the 100 Mev betatron are expected to throw new light on our knowledge about nuclear processes Many tentative or empirical formulas may be verified, at least, for the energy range provided by this apparatus

100 Mev appears to be the upper limit of energy that can be imparted to the electrons, in an arrangement like betatron ; because the radiation loss of energy of the electrons becomes so pronounced that the electrons cannot be accelerated for any longer period with benefit It is possible, however, to increase the energy by using higher frequency than that used in the 100 Mev, *viz* , 60 c/s In that case the electrons will gain 100 Mev within a shorter period and it may be possible to allow them to rotate for a further period without serious loss due to radiation But the use of higher frequency has its inherent troubles of insulation and such other practical difficulties

The Synchrotron

A recent suggestion from the University of California indicates the possibility of producing

energies much higher than 100 Mev, using an apparatus, like cyclotron under the name "Synchrotron". The phase lag of the frequency of the angular velocity of the revolving ion, with that of the alternating electric field, in a cyclotron, due to relativity increase of mass, destroys the "resonance" condition This essentially puts the higher limit of energy Now it is suggested that if this phase lag is somehow eliminated and the two phases synchronized, the relativity increase of mass can not set the upper limit of energy The synchronization, according to the suggestion, can be done either by increasing H proportionately or by changing (decreasing) gradually the frequency of the r f voltage at the "dees" This requires either the use of a varying magnetic field or some mechanical means of continual change of frequency The use of a varying field will not only make the successive ion paths shorter and thus keep phase with the r f voltage peak but will produce additional acceleration because of the induced electric field, as in a betatron The suggestion further indicates that the axial and radial focussing conditions are satisfied and both electrons and heavy positive particles can be accelerated by this method For electrons, it is much easier to synchronise the two phases by varying H, instead of changing the frequency of the alternating electric field For heavy particles, however, up to 300 Mev, the frequency change necessary is only 30 per cent Thus it appears practicable to vary frequency in the case of the heavy particles The dimensions for such an apparatus for producing 300 Mev electrons are as follow

Peak $H = 10{,}000$ gauss
Final radius of the orbit = 100 cm
Frequency = 48 Mega cycles per second
Initial energy of the electrons = 300 kv
Initial radius of the orbit = 78 cm

The electron source, unlike the cyclotron, has to be placed at a distance of about 78 cm from the centre and to be projected with an initial energy of 300 kv During the acceleration period the orbit expands by 22 cm only So the magnetic field need only cover an annulous space between 78 cm and 100 cm nearly For a voltage 100,000 between the "dees", the phase shift will be 13° only

It has been shown by J Schwinger that the loss of energy due to radiation will not be serious in synchrotron According to his mathematical relation, the total radiation loss in synchrotron is independent of energy, for very high energy, *i e*, where final energy is much greater than the rest energy The radiation loss, however, depends on the number of electrons in the beam For the design suggested, the total radiation loss has been calculated from Schwinger's formula to be 21,00 volts only, for $N = 10^{11}$, corresponding to 1 μ A current at 60 cycles/sec, where ratio of the total energy and rest energy = 600

The research staff of the California University has now under consideration the designing and construction of a 300 Mev synchrotron in their laboratory This apparatus is sure to reveal even more interesting results

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Notes and News

THE HIRAKUD DAM OF THE MAHANADI VALLEY PROJECT

THE foundation stone of the Hirakud Dam of the Mahanadi Valley Project was laid by His Excellency Sir Hawthorne Lewis, Governor of Orissa, on March 15, 1946 The Hirakud Dam will be the first of the three dams proposed to be constructed on the Mahanadi, with a view to harnessing the water power of this mighty river The dam will be at Hirakud, after which it has been named, 9 miles above Sambalpur The other two dams will be located at Tikkerpara some 130 miles down stream, and near Naraj about 10 miles upstream of Cuttack

The Hirakud Dam will be about 100 feet above the bed rock with a reservoir level of 610 feet above the mean sea level An area of about 130 square miles will be submerged by the reservoir The dam will impound four million acre feet of water, of which one million acre feet will be reserved as dead storage, 1·5 million will be made available for purposes of irrigation and power development (live or usable storage), and 1 5 million acre feet will form the flood reserve to absorb flood peaks The dam, through a network of canals, will provide perennial irrigation to nearly 800,000 acres in the district of Sambalpur and in Sonepur and other Eastern States The hydro-electric power plants to be erected at the dam will have an installed capacity of 50,000 kw and it is proposed to link the Hirakud hydro-electric power project with the Machkund power development

Hirakud, where the foundation rock has been found, by preliminary geological investigation, to be composed of granite gneiss, quartzites and phyllites, has been a good choice for the construction of a high dam such as is now projected The occurrence of lime-stone, the raw material of cement which is one of the most expensive items in dam construction, is reported in the neighbourhood

The aerial survey of the dam site and reservoir area and preliminary geological investigations have been completed The ground control for the aerial survey is now in progress ; the contour survey of the area to be irrigated and detailed geological investigations at the dam sites will be taken up early when equipment is available. The whole project is expected to take about 5 years.

The biggest in Orissa, the Mahanadi is one of the big rivers in India and drains an area of about 51,000 square miles, above its debouch into the delta. In times of flood, the river is capable of a maximum discharge of 1 5 million cusecs, which dwindle into 200 cusecs only during drought The annual flow has been variously estimated to be between 60 million and 90 million acre feet, which is four times that of the Colorado river in U S A , across which world's highest dam, the Boulder Dam, has been built, and is about as large as that of the great Indus river at Kalabagh The Mahanadi Valley Project proposes to impound roughly one-sixth of this annual flow or just over 10 million acre feet each year, through the construction of the three dams at Hirakud, Tikkerpara and Naraj These dams will make provision for a gross storage of 20 million acre feet, to be divided into three parts Five million acre feet will always be reserved as 'dead storage' at the bottom of the reservoir which will provide a silt reserve for a period of above 100 years, thus eliminating one of the most difficult problems of storage dams, namely their short life owing to silting of the reservoirs Fifteen million acre feet will be available for use in perennial irrigation and for purposes of power development The remaining five million at top will act as flood reserve A chain of lakes will be formed as a result of these dams , the one formed by the Naraj Dam will extend to the Tikkepara Dam, while the lake consequent upon the Tikkerpara Dam will extend to Sonepur about 60 miles above Hirakud

The whole project, when completed, will provide navigation facilities over a length of about 300 miles, from the sea to the head of Sambalpur reservoir Over 2 5 million acres will receive the benefit of perennial irrigation The possible development of hydro-electric power has been estimated at 200,000 kw The exploitation of the very rich mineral resources of Orissa, to be rendered possible by the availability of cheap hydro-electric power, will immensely contribute to the material well-being of the province as a whole Reclamation of water-logged areas and control of malaria are also reported to constitute important features of the project.

HYDRO-ELECTRIC POWER IN INDIA

ON the basis of the most recent statistics available, Mr George Kuriyan, Head of the Department of Geography at the University of Madras, estimates that the total developed hydro-electric power in India is approximately 500,000 kilowatts or about 6 per cent of the probable potential resources of some 12,000,000 kilowatts (*Ind Geog Soc Monograph, 1*, 1945)

This is a low figure and more so when compared with the percentages of developed power in other countries, e g , Switzerland, 72 , Italy, 47 , Japan, 37 , United States, 33 , Canada, 25

Of the installed power in India some three-fifths are supplied by (1) Southern India (Madras, Mysore and Travancore) with 195,500 kilowatts and (2) Western India (Bombay, Baroda and Sind) with 183,500 kilowatts

As long ago as 1880, the Famine Commission pointed out that "only remedy for the recurring disasters" of famine was "the rapid industrialisation of the country providing diversified employment to the large population" Little progress has been made so far Recent statistics show that about two-thirds of the total working population are directly dependent on agriculture and only 1 per cent are employed in organized industries

India possesses raw materials for both electro-chemical and electro-thermal industries It has also considerable resources of high grade iron and manganese which could readily form the basis for steel manufacture and the construction of ships, locomotives and heavy machinery The development of the hydro-electric resources is therefore of great importance in Indian economy and would make possible the building up of a number of useful industries

With construction of storage reservoirs and sub-station net-work, the two major disadvantages of hydro-electric power, e g , seasonal character of monsoon rainfall and the vast distances of transmission could be obviated Water power should prove more economical than power generated by other means

WATER HYACINTH

HERBICIDAL action of 2, 4-Dichlorophenoxy acetic acid on the *Eichornia Crassipes* (Water Hyacinth) is reported by E M. Hildebrand of the Food Machinery Corporation, Florida (U S.A) (*Science*, April 19, 1946)

In April, 1945, Hildebrand first tested 2, 4-D (1 1430) for eradicating the water hyacinth in a flowing stream of water In preliminary trials promising results were obtained by spraying with a Knapsack sprayer from the shore The amount of material employed was about one gallon per 100 square feet for plants about 15 inches tall.

The first conspicuous symptom of herbicidal action of the spray resulted in an abrupt epinasty of the upper part of leaf petiole and subsequent discoloration by the end of two weeks and death occurring in about three weeks The stems separating from the roots and the dead parts disappearing in the stream either by sinking or floating away

In a second and third experiment with 2, 4-D (1 1140) and 2, 4-D plus carbowax 1500 respectively, practically 100 per cent kill was obtained

No adverse effects to the water fauna were observed Since 2, 4-D is a growth substance for plants which operate on the "hormone" principle, injurious effects to water fauna were not anticipated

Later, in October, a second series of experiments were conducted on water hyacinth growing in relatively quiet water where the growth was vigorous, dense, and 16 to 24 inches tall One gallon of 2, 4-D spray (1 800 to 1 1700) when applied in 100-square-feet plots and replicated three times, gave practically complete control When rain fell before 2, 4-D spray had time to dry or be absorbed by the leaves the herbicidal action was largely lost

The possibility that important waterways might be cleared of the water hyacinth by means of 2, 4-D invites trial in India, on a large scale We draw the attention of the relevant authorities to this remarkable discovery The problems of water hyacinth in Bengal is similar to that in the United States and in Bengal it is much more of a threat (SCIENCE AND CULTURE, *11*, 1945) Hence, this new method of eradication invites a trial

ARTIFICIAL PRODUCTION OF ELEMENTS—43, 61, 85, 87

ALL the gaps in the period table are now reported to have been bridged with the artificial production of four chemical elements of atomic numbers 43, 61, 85, and 87, now known to be extremely rare or non-existent in nature (*Science News Letter*, April 6, 1943) This significant announcement was made by Dr Glenn T Seaborg, professor of chemistry at the University of California, before a meeting of the physical chemistry section of the American Chemical Society

The existence of these elements has been confirmed by experiments involving 'tracer' technique, in which the course of the elements in reactions is followed up by their radio-activity Dr Perrier and Segre produced radio-active isotopes of element 43 by bombarding molybdenum with deuterons and showed that in chemical properties the element 43 resembled rhenium more than it did manganese

The element 61 is a rare earth The radio-active forms of this element were discovered by Drs Kurbatov and Pool and by Drs Wu and Segre

Drs Corson, Mackenzie and Segre studied the properties of the radio-active isotope of element 85, which was produced by bombarding bismuth with 32 Mev alpha particles The atomic weight of this isotope is 211 and, unlike other halogens, resembles a metal in its general behaviour.

A radio-active isotope of element 87, obtained as a result of decay of actinium and named Ac, was discovered by Dr Perey. The isotope has a mass of 223 and resembles a heavy alkali metal. It decays by emitting a beta particle and has a half life of 20 minutes.

AMERICIUM AND CURIUM FOR ELEMENTS 95 AND 96

A SUITABLE nomenclature of the trans-uranic elements, recently discovered as a direct consequence of atomic bomb research, presented some difficulties. The element 92 which was until recently the last member of the periodic table was named after the planet Uranus. When the two trans-uranic elements 93 and 94 were discovered, it was natural that they were named after the two remaining planets Neptune and Pluto. The element 93 was called neptunium and the element 94 plutonium. When, however, the elements 95 and 96 were discovered by workers in the Metallurgical Laboratory at the University of Chicago, of which an account appeared in the June issue of our journal, there were no more planets of the solar system left, after which to christen them.

Dr Seaborg, the co-discoverer of elements 95 and 96, has suggested the name "americium" for element 95, after the Americas and "curium" for element 96, after the Curies (Pierre and Marie), the pioneers in the study of radio-activity.

In the past, new elements were, however, named after the country of discovery or after the name of persons. The element hafnium was named after Copenhagen, the native place of Prof. Bohr, where it was discovered. The rare earth element gadolinium was named after Gadolin, a great investigator of the rare earths.

INDIAN CENTRAL JUTE COMMITTEE

A REPORT on the scientific investigations of the Committee, carried out during the year 1944-45, states that 319 samples of jute types were collected from three Bengal districts and Purnea district of Bihar. Species of *C. auxillaris*, a species of cultivated jute recently reported from China and unknown in India, were obtained through the courtesy of Dr C. F. Feng. One of the two mutants found near Dacca proved to be completely sterile and the second a diploid trisomic chimera.

Progenies of o 39-139 and o 40-103 coming from selections made in 1939 and 1940 respectively, have maintained their superiority over the control shown in the earlier trials, being 10 to 20 per cent higher in yield. Since then, it is reported, that C39-212 and C41-13, the two strains evolved by the Jute Agricultural Research laboratories have proved definitely superior to the local variety, the mean yields being 19.75 and 20 mds. per acre respectively, as against 17.9 mds. per acre of the local.

Examination of the three years' data on effect of fertilizers on yield and stem rot has shown that (1) yield increases proportionately to doses of both N and K, the action of these being independent, (2) stem rot is unaffected by N but decreases proportionately to doses of K applied and (3) of the dosage of fertilizers tested, N_2K_1 proved to be most profitable.

Two species of *Wooly Aphis* were observed for the first time on jute towards the end of the season. These attack the stem, petiole and pods. Preliminary studies on the life history of one of the species of *Wooly Aphis* (white in colour) were carried out.

Continuing the report says that the closest spacing of jute plants ($4'' \times 4''$) has consistently given the best quality of jute fibre and the widest ($9'' \times 9''$) the worst. The harmful effect of over retting has been proved beyond doubt; jute stems should not be left steeping for a period longer than normally necessary in the hope of softening any barky root-ends that may be present. This information is useful to the jute growers.

A comparison of three varieties of white jute and three of Tossa, grown for five years, shows that *Fanduk* gives better quality than the well-known *D154*, and *R26* better quality than *Chinsurah green*. Yields of *Fanduk* and R26 may be lower and this underlies the importance of proper grading and payments in accordance with quality.

Data are given in the report which shows that the middle part of the jute stem gives the best fibre, and it is suggested that both root and crop should be cut off for the spinning of high quality fine yarns.

Tests on commercial samples show the relative quality of jute from various centres and for both white and Tossa it is found that the best qualities come from Mymensingh, Dacca and Tipperah. It is noteworthy that Assam has provided some samples of very good quality. These results provide, perhaps for the first time, reliable quantitative data regarding different types of jute and it can be seen that the annual collection of such data will give information of first rate importance.

One important item that deserves special notice of the jute trade is the work on the effect of twist on yarn strength and the choice of twists for yarns intended for warp and weft. The use of twists that are too high or too low means a big waste of money on the production of goods that are not as serviceable as they might be.

The report shows that many subjects of fundamental importance have received close attention, providing a foundation for attempts to improve the quality of jute and find new uses for it.

The various university research schemes reported for the year 1943-44 (see SCIENCE AND CULTURE, June, 1945) were continued. One new scheme for research on the physiology of the jute plant, under Prof J C Sen Gupta of the Presidency College, Calcutta, was sanctioned during the year under review

The Committee is being financed out of the Central Revenues, with a grant-in-aid of Rs 5,00,000 received from the Government of India The Bengal Government contributed Rs 10,000 towards the scheme for Jute Research Sub-stations in Bengal

Expenditure included Rs 52,000 on general administration of the Committee, Rs 91,000 and Rs 1,52,000 on measures taken in connection with work on the improvement of the agricultural and technological researches on jute respectively, Rs 26,000 on measures taken in connection with improvement in the marketing of jute, Rs 6,000 on scheme for the improvement of jute forecast, Rs 46,000 on scheme for economic research and publicity on jute and Rs 1,83,248 on scheme for the employment of special agricultural staff in Bengal, Bihar, Assam and Orissa

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE annual report for the year 1945 on scientific work of the Association states that the detailed study of extra reflection of X-ray of which the origin is traced to linear derangement waves in crystals is in progress The intensities of these reflections fall off very rapidly showing that the wave-lengths of the derangement waves responsible for these extra reflections are long

The effect of chemicals and dyestuffs on jute and other fibres containing cellulose are being studied by means of X-rays Organic dyestuffs (methylene blue and Congo red) did not produce any change in the structure of the cellulose in the jute fibres Complete delignification by the action of ClO_2 produced partial dishevelling of the cellulose fibres X-ray photographs of a wide variety of vegetable fibre have shown that the position of the maximum intensity in the diffraction spots are identical for all these fibres High tensile strength has always been found associated with sharpness of the spots

The Raman spectra of organic substances—ethylene di-bromide, aliphatic ketones, and the mixture of *trans* and *cis*-dichloro ethylene, have been studied in the solid state at low temperature at about 170°C and in the liquid state at room temperature The results obtained do not corroborate the conclusion of previous authors

Investigations were also continued on the X-ray diffraction study of solid solutions of salts and metals in borax and boric acid glasses, on the electrical and magnetic properties of single crystals of molybdenite and on the absorption of fluorescence spectra of some organic crystals

The Jay Kissen Mookerjee Gold Medal for 1941, 1942 and 1943 were awarded to Prof R A Fisher, F R S, Mr D N Wadia, F N I and Prof S K Mitra, F N I who delivered lectures during the year under review on "Application of Statistics to Human Genetics", "Petroleum Resources of India" (See SCIENCE AND CULTURE, *10*, 484, 1945) and "Active Nitrogen—A New Theory" respectively

Cooch Behar Professorship lectures for the years 1939, 1940 and 1941 were also delivered during the year under review by late Sir U N Brahmachari, F N I, Prof J N Mukherjee, F N I and Prof P Rây, F N I on "Contributions to the studies of the Chemistry and Chemotherapy of certain new Quinoline Compounds", "the Role of electrical double layer in the electro-chemistry of Colloids with special reference to Clays" and "Valency and the Structure of Chemical Compounds" respectively

Dr R C Mazumdar, F N I delivered a course of 4 lectures on "Meson Field", as Ripon Professor for 1940

The Association received a grant of Rs 20,000 from the Government of India, while the University of Calcutta printed free of cost the "Indian Journal of Physics" of which six issues were published during the year The Corporation of Calcutta exempted the payment of municipal taxes for the Association premises, No 210, Bowbazar Street, Calcutta The Association has on its role 251 members of whom 150 are life members

INDIAN CENTRAL MICA COMMITTEE

THE Government of India appointed a committee in 1944 (with Mr Justice Reuben as *chairman*, Messrs Gurusharan Lall and M Mohammed Ismail, *members* and Mr R H Prasad as *Secretary*) to examine the conditions prevailing in the mica trade and industry for ensuring conservation and development of this important mineral in an economic manner and provide means for research both in the field and in the laboratory (See SCIENCE AND CULTURE, December, 1944, p 242)

Mica is a mineral of key importance vital to electrical industry and is almost an Indian monopoly with assured export market Before the war over 70 per cent of world's supply of muscovite mica came from India and during 1940-43 the output of dressed mica averaged roughly between 140,000 to 185,000 cwts. The best variety comes mostly from the Bihar mines, which are scattered over an area of about 19

to 20 square miles in the Hazaribagh and Gaya Districts

In 1944, mica worth Rs 2,73 crores was exported from India and during the war, India supplied between 80 per cent and 90 per cent by value of the total splitting imports of the U S A The U K which used to import on an average 47,095 cwt of block mica and splittings valued at Rs 0 45 crores, in the pre-war years, is India's next important customer India must now be prepared to meet keener competition than in the past from Brazilian mica and the possibility of developing synthetic mica in Germany during the war cannot be dismissed lightly (See SCIENCE AND CULTURE, March, 1946, p 482)

The Report of the Mica Enquiry Committee, (Manager of Publications, Civil Lines, Delhi 1946, states that there need not be any apprehension that India's mica resources are exhausted The real danger to conservation lies in the improper methods of mining that are both primitive and wasteful The Committee desire to prescribe standards of quality for Indian mica and as an interim measure they suggest that the standards established by the Joint Mica Mission should be maintained The need for central legislation to ensure uniformity between all the areas producing mica is further emphasized

Fairer prices for Indian exporters, through scientific grading and marketing, conservation of mica by compulsory employment of proper mining methods, increased use of the mineral in indigenous industries (the quantity of mica utilized in India at present is estimated at about 5 per cent of the total output) and encouragement to the production of micanite and ground mica are the main objectives of the industry

For realization of these aims the Committee recommended (1) the setting up of a Mica Marketing Control Board for watching the interests of the trade, (2) establishment of a Central Mica Committee on lines of other commodity committees to control and direct research, (3) establishment of a research station, under an eminent scientist, (4) wider application of the "Indian Mines Act, 1923" to mica mines, (5) levy of a cess of a 6 per cent *ad valorem* duty on all mica exports for the creation of welfare funds for providing housing and other amenities to labour and for research in the interests of the industry, and (6) propaganda for increased use of mica by indigenous industries

Estimating the annual export of mica at Rs 1 crore the suggested levy would yield an annual income of Rs. 6 lakhs The Committee recommends the allotment of a third of the revenue to the Central Mica Committee, which will be responsible for research. We desire to emphasize the immediate need for ascertaining the basic research requirements of the industry and we hope that plans for establishing a research organization will not be deferred indefinitely In the shaping of this research institute, the universities and similar research supporting bodies should have representations on the committee Research "on the dielectric constant and on the breakdown voltage of different types of Indian mica" was undertaken in 1940-41, in the laboratories of the Ghosh Professor of Pure Physics in the Calcutta University and the results obtained were of much practical value

A separate report on the "Mica Mining and Manufacturing Industry" prepared by the Labour Investigation Committee appointed by the Government of India (Mr D V Rege, *Chairman*, Mr S R Deshpande, Dr Ahmad Mukhtar and Prof B P Adarkar, *Members*), revealed that a radical remedy was required for saving the Indian mica miner and worker from exploitation Wages, specially of the splitters, are perhaps the lowest in the world. Nearly 250,000 workers are employed directly or indirectly in the industry while 500,000 more are dependent upon them for their livelihood In view of this, and because of the strategic value and importance of the mineral, it is necessary to place the industry on a sound footing not only on the technical and commercial side but also on the labour side The industry has risen not only on account of the rich deposits but also due to the availability of cheap skilled labour, which by years of experience has acquired superior skill and efficiency In fact, mica is shipped from Brazil, U S A and Canada to be split by the highly trained Indian workers

The principal evils which exist in the mines are due to the defects in the "Indian Mines Act, 1923" and laxity in its application In 1943, there were 113,810 workers in the mines including women and children employed in violation of the law

As remedial measures the Committee suggests immediate action for (1) enforcement of the Indian Mines Act, (2) regulation of wages and hours of work, (3) compulsory wet drilling, (4) substitution of ladders by cage lifts, (5) provision of better lighting, drinking water, sanitation, anti-malarial measures, hospitals and dispensaries, (6) supply of cheap grains and (7) control of liquor.

MYSTERY AROUND VAVILOV'S DEATH

KARL SAX (of Harvard University) has raised the question of political interference in research in U S S R, with pointed reference to the fact that Vavilov, (one of the most famous Russian scientists, who rendered outstanding service to his country), Navachin and Karpetchenko, (all of whom took a prominent part in opposing Lysenko, as their scien-

tific views were not in conformity with Marxian ideology-Vavilov-Lysenko controversy), were not heard of for many months. (*Science*, 1944, 99,298; 1945, 102, 649).

Contradicting Sax, Anton Zhebrak (of the Timiriazev Agricultural Academy of Moscow) asserted that genetic research in U S S. R. is wholly free and untramelled. He cited recent publications of Navachin but he made no mention of Vavilov and Karpetchenko (*Science*, 1945, 102, 357)

Sax asked, "Why and how Vavilov died?" Vavilov "was arrested by NKVD in the summer of 1940 and has been kept in custody since then" (*Chronica Botanica*, 1941, 6, 429) A list of the members of the U S. S R Academy of Sciences distributed to the members attending the 220th anniversary of the Academy in 1945, reveal that the list does not contain the name of Vavilov and Prof M. N Saha, F R.S., who represented India at the 220th anniversary reported that 'Vavilov died about two years ago' (SCIENCE AND CULTURE, 1945, 11, 109)

Similarly, a member of the U S A. government mission reported that Vavilov died in the early months of 1945 but they obtained no information as to the circumstances of his death This is confirmed by a story from Britain that a communication announcing Vavilov's election as a corresponding member of the Royal Society was returned with the remark that Vavilov had died in 1945 (*Journal of Heredity*, January, 1946)

Since then, Vladimir Asmous (of the Arnold Arboretum, Harvard University) writes that they have now reliable information that Vavilov was put to death in a concentration camp in Siberia in 1942 (*Science*, 1946, 103, 282)

Earlier, Harland and Darlington in an obituary note on Vavilov (*Nature*, 156, 621, 1945) writes that the circumstances are not precisely known of Vavilov's death "but the time was after December, 1941 and the place probably Saratov"

SIND SCIENCE RESEARCH SOCIETY

WE are glad to note that a Society of Scientific Researchers to be called "Sind Science Research Society" has been started in Karachi with Prof Maneck B Pithawalla, as the Founder President and Prof C S. Narwani as the organizing secretary The Society has the four-fold objects of (*a*) encouraging and co-ordinating scientific researches in Sind and scientific investigations carried on by the members, (*b*) organizing series of popular lectures on scientific and industrial subjects, (*c*) establishing a library of scientific and industrial literature for the use of members and (*d*) publishing a journal of research work, pertaining to the province of Sind.

The membership of the Society has been restricted to post-graduate research workers, recognized university teachers and laboratory researchers of Government departments and industrial concerns in Sind, with a view to giving the Society an All-India status. A bulletin containing a review of scientific investigations carried on by the members and others, will shortly be issued and it is expected that there will be a prosperous future for the Society in a young province like Sind

HISTORY OF SURVEY OF INDIA

A HISTORY of the Survey of India in a series of volumes, entitled "Historical Records of the Survey of India", is being published by the Surveyor General of India This series, the Volume I of which, covering the 18th century, has now been issued, is being collected and compiled by Col R H Phillimore, formerly of the Survey of India It is designed to give a full and detailed account of the work of the surveyors and geographers of India, and has been prepared from official records of the Department, of the Central and Provincial Governments, of the India Office and also from records of the British Museum. These Records reconstruct the history of surveys in India from the earliest days of their inception and simple beginnings in the 18th century and aim at bringing it up to date

The Volume I of these Historical Records describes the work of the 18th century, "a period of romance and adventure" It describes the adventures and difficulties of surveyors working in a vast country, about the geography of which little real knowledge was available up to the 18th century The work of surveyors and map-makers has been described in its close relation to the political history of the country Not only topographical or geographical surveys but also land surveys for revenue purposes and astronomical control have been dealt with

The Volume II will deal with the period (1800-1815) of the historical development of Indian surveys, when regular organization and system was brought to the topographical surveys of the Madras Presidency by Colin Mackenzie and the foundation of the Trigonometrical Survey of India was laid by William Lambton.

The Volume III will cover the period (1815-1830), when all the surveys were co-ordinated under one Surveyor General of India, and Lambton's trigonometrical survey of the South Peninsula was extended as framework for the geography of the Continent at that period A Revenue Survey Department was established to provide professional control for such surveys, and the great Atlas of India was started to cover the whole of India with a continuous map on a uniform scale.

ANNOUNCEMENTS

DR K T JACOB, M Sc, Ph D, Cytogeneticist, Bose Research Institute, Calcutta, has been appointed Reader in Botany, Andhra University. Dr Jacob has served in the Bose Institute since 1942, and was engaged in investigations on the selection and hybridization of cotton of various strains financed by the Bengal Government, on the effect of irradiation on different strains of jute financed by the Indian Central Jute Committee, on the cytogenetics of cinchona financed by the Central Government, and on the hybridization of yeast, financed by Bengal Immunity Company

Mr Shyamadas Chatterji, M Sc, of the Bose Research Institute, Calcutta, has been admitted to the degree of doctor of science of the Calcutta University for his thesis on "Investigations in Nuclear Disintegration"

SCIENCE IN INDUSTRY

DEVELOPMENTS IN PLASTICS

THE latest developments and advances in the field of plastics, concerning their composition, moulding and fabrication, properties, testing and specifications, and applications have been recorded in a very interesting review published in *Modern Plastics* (25, 161, 1946) The article, which comes from the pen of one of the leading American authorities on the subject, *viz*, Dr Gordon M Kline, Chief of the Plastics Section, National Bureau of Standards, includes a bibliography of 287 references and forms an excellent index for further investigations

According to Dr Kline, the latest newcomer in the plastic field is cellulose propionate, whose production has been rendered possible by the development of a new process for making propionic acid from cheap hydrocarbons obtained from petroleum and natural gases It finds use in the form of sheets, films and moulded products and possesses better dimensional properties than cellulose acetate plastics As a result of several investigations by technical teams that followed the Allied armies into Germany, it was revealed that that country produced many types of plastics unknown elsewhere, such as polyvinyl pyrrolidone, polyethyleneimine, polyurethanes and many other copolymers of vinyl chloride, styrene and acrylic esters The newly developed silicone polymers continued to be used on searchlights and turbo superchargers of planes, while silicone resin enamels are advantageously used for baked coatings on ranges, radiators, heat exhaust pipes and stacks. The production of polyethylene film, capable of resisting water and fungus, with good flexibility and heat sealability properties, rendered this plastic useful for packing anti-malarial mepacrine The development of polystrene and cyclohexyl methacrylate for optical purposes was one of the major developments during this war; the other developments being flame resistant cellulosic plastics, the use of melamine resins for decorative and panel boards having high impact resistance, and the use of phenolic casting resins for plating shields, foundry patterns, die forming and other fixtures

In the formulation of tough plastics, a reinforcing wood pulp filler has of late received considerable attention, while paper, cotton-fabric and glass-fabric reinforcement have also been investigated, for development in fan and propeller blades According to the author, the development of sandwich fuselage structure, 50 per cent stronger than similar metal sections, appears to have future possible outlets in low-weight furniture, refrigerators, stoves, and insulation Among other developments, mention is made of the manufacture of resins from cashew nut shell liquid, rosin esters, alkyds, vinyl elastomers and keratin-modified phenolic plastics

In the fabrication methods, many new techniques are reported, such as low-pressure moulding,—an art which was classifiable as laminating, gluing to contour, plastic forming and resin curing to contour,—compression moulding by electronic preheating, the adaptation of radio frequency heating in injection presses, and improved equipments for heat-sealing highly oriented thermoplastic films A new method very recently evolved for welding thermoplastics for the purpose of uniting lens components and sealing compasses was to rub the two pieces together at high surface speeds (100 r.p.s. for a 1 inch diameter methacrylate rod) and then rapidly apply a pressure of nearly 300 lbs./sq. inch for a few seconds.

Amongst the latest applications of plastics which have become known as a result of the release of war time secrecy, mention is made of the proximity fuse; rockets; smoke grenades; plastic radomes in radar; ogives for navy projectiles, machete sheaths; and melamine trays. In the aircraft industry, plastic was increasingly employed for air ducts, interior decoration, hydraulic systems, and propeller equipment as well as in the broader applications in gliders, and helicopters. Plastics are also finding applications in

small boat construction ; in building industries , in prostheses, gauges and other appliances in the medical profession ; as soles of shoes ; in the textile industry for impregnation and surface treatment , as films for packing ; and as resin-bonded magnets, irrigation piping, battery separators, and tank and brake linings Industrial utilization of ion-exhange resins on an expanding scale has been indicated by articles pertaining to their roles in purification of food products, recovery of metals and manufacture of drugs.

On the purely engineering side, the field has been explored by the evaluation of results connected with the mechanical strength creep, plasticity, permanence, dimensional stability, fatigue, impact, and flame—resistance, flexural, compressive, and torsonal strength, permeability, hardness values, thermal electrical and aging characteristics of various types of plastics In the testing and identifying of these materials the use of X-ray, infra-red, microscopic and chemical methods have been adopted while the high-polymer field has been successfully explored by ultrasonics. By expanding the field of research and investigation into these new class of materials, a broad and ever increasing scope of adaptability can be assured for plastics in all branches of engineering and industry

S K G

BUTTER FROM COAL

A NOTE in *The Chemical Age* of June 1, 1946, makes an interesting reference to the successful production of butter from paraffin, a by-product of coal, in Germany. It is reported that, during the war, the Germans were producing this synthetic butter at the rate of 150-200 tons per month. This production is now being stepped up to 350 tons per month as greater supplies of paraffin are being available

The firm concerned in the production of this synthetic butter is the Imhausen Soap Manufacturing Plant at Witten, Ruhr, of which Dr Karl Heinz Imhausen is the present managing director and Dr Hermann Rossow the chief chemist The process was first invented in 1935 by Arthur Imhausen, father of the present director. The paraffin is first oxidized and then heated to extract the fatty acids. On further distillation, the fatty acid is used either for making butter or soap. For butter, the acid is distilled again, and glycerin and carotin are added to the distillate. 100 tons of paraffin yield about 80 tons fatty acids with which to make about 40 tons of either butter or soap. Butter produced by the Imhausen process contains no acetone and can be safely taken by diabatics.

Production of a special anti-dermatitis soap at this factory is also of interest The soap contains 80 per cent fat and is generally distributed among the miners. The soap for ordinary Germans contains only 30 per cent fat

SPECULUM COATING

SPECULUM is an old alloy of tin and copper (tin—45 per cent and copper—55 per cent), known since very early times The speculum mirrors received great popularity during the Roman period and after and were used in reflecting telescopes by William Harschel who built a 48″ reflector and discovered Uranus With the development and perfection of the technique of silvering, speculum later gave place to glass and, thus deprived of an important commercial use, long remained a less useful alloy Recently, however, the bright surface of the alloy and its comparative freedom from being readily tarnished have been successfully utilized in developing a new type of electroplated coating, *e g*, the speculum coating, which bids fair to compete in time with the silver, nickel, and chromium coatings as a decorative finish (*Scientific American*, May, 1946) The technique of the speculum coating was developed in England by the Tin Research Institute of London and was first commercially adopted in Birmingham in 1939 During the war this work had to be given up owing to shortage of tin and heavy demand on metals With the improvement in the supply of tin, it is being gradually taken up

In the process of electro-deposition of the alloy, both tin and copper are simultaneously allowed to be deposited In the bath, tin is taken in the form of sodium stannate and copper as cyanide, with free sodium cyanide and caustic soda also present Speculum, because of its high corrosion, cannot be used as anodes ; instead, separate tin and copper anodes are used to replenish the metal content of the electrolyte The electrical circuit to the two anodes is split and an arrangement for individually adjusting the current is introduced Sound chemical control is necessary to maintain the correct condition of deposition ; such control involves regular checking of the cyanide and caustic soda contents every two or three days, and of tin and copper every two or three weeks.

Speculum coating requires only one coating, no undercoat being necessary. The thickness of the coating usually varies from 0 0005 to 0 001 inch, depending on the service life required The preparatory polishing and final burnishing are also reported to be less than those involved in nickel-chromium coatings.

Speculum coatings have been successfully applied directly to steel, iron, tinplate, nickel-silver, copper,

brass, bronze, etc. In colour, speculum coated articles appear very much like polished silver, being less blue than chromium and less yellow than nickel The coatings stand reasonable amount of deformation and do not suffer from flaking or spalling Speculum has already been used in plating electric lamps and fittings, jewelry and tableware, cigarette cases and lighters, bathroom fixtures, etc.

COMPRESSION DISTILLATION

SPECIAL importance attaches to the new methods, namely the compression distillation, of producing distilled water which is capable of producing pure water containing less than one part per million of impurities, directly from the saline water of the sea Originally developed for producing battery water on board the submarines, the method has great industrial possibilities, as it makes available extremely pure water at a very low cost (less than 10 cents per hundred gallons) Photographic industries, pharmaceutical and chemical industries, high-pressure steam plants, railroads, sugar refineries, textile factories, paper mills and various other industries requiring very large quantity of water, are expected to be greatly benefited from the new process when its industrial possibilities are fully developed A brief account of the process by R V Kleinschmidt, of the Arthur O Little, Inc , which significantly contributed to the process and developed distillation units, has appeared in the *Scientific Monthly*, April, 1946.

Normal operation of a compression still is preceded by heating to bring the apparatus to operating temperature and fill the evaporation compartment with steam. In regular operation, sea-water feed enters through a triple-passage heat exchanger in which it extracts heat from the outgoing distillate and the brine carrying away waste salts The feed enters the evaporator at about 207°F. and mixes with a relatively large volume of brine circulating naturally. From the evaporator, steam is led through an entrainment separator to the compressor, which raises its pressure to about 3 pounds per square inch gauge. At this pressure, the steam condenses at about 222°F. Since the brine boils at 213°F., there is a 9° temperature differential to permit transfer of the latent heat from the condensing steam to the boiling brine. No separate condenser or cooling water is needed In some of the more recent models, more than 157 pounds of distillate have been produced for each pound of fuel used.

In 1941, compression stills were fitted into the submarines being built at that time, for production of the battery water The distilled water from the stills had less than one-tenth of the impurities permissible under Navy specification for double-distilled battery water In addition to its great purity, the water is also remarkably sterile inasmuch as it has to be heated to over 240°F

INSECTICIDES

S B SEN GUPTA,

MESSRS STANDARD PHARMACEUTICAL WORKS LIMITED, CALCUTTA

INSECTICIDES are divided into two groups according to their mode of action against insects Those materials which kill by contact with the body of the insect are called contact poison or eradicant insecticides, and those which must be ingested before they become effective are known as stomach or protective insecticides.

STOMACH POISON

The arsenicals are the most widely used group of stomach poison and lead arsenite is the most widely used arsenicals at present. It is almost an ideal insecticide It is easily produced in a light flocculent form which can be easily dispersed in water. After application it forms uniform deposit on plants and exhibits a high degree of tenacity. It is not readily decomposed as are most of the other arsenicals Sometimes, it causes injury to plants but to a much less extent than any other arsenical materials

Calcium arsenite, because of its higher arsenic content and its relative cheapness, is sometimes used in preference to lead arsenite, but calcium arsenite is relatively unstable and, unless used with excess of lime, causes serious injury to plants. It is commonly used to plants more hardy and less susceptible to injury.

Paris Green is a complex compound of copper meta arsenite and copper acetate in which the ratio between the two is usually nearly 3·1 but it may be as low as 2.1. Paris Green rapidly settles down from its suspension in water and has very poor adhesive qualities At present it is seldom used as

insecticide on crops. It is, nevertheless, finding considerable use as larvacide to control mosquitoes. For this purpose, it is diluted with road dust, powdered charcoal or clay and dusted on the surface of the stagnant pools of water.

Compounds of fluorine, fluorides, fluosilicates, fluoborates, fluoaluminates etc. have been used as insecticide against household flies. Volumes of work have been done on this subject, on which an extensive literature has accumulated. In general, soluble compounds of fluorine, both organic and inorganic, have been used as moth-proofing agents, household insecticides, fly poisons, and poison baits, while insoluble compounds have been used on field crops. The compounds of fluorine are toxic to all forms of life and should be used with great caution. Cryolite for dusting and spraying fruits and vegetable seems to enjoy the largest popularity in use and sodium fluosilicate is a useful poison for grasshopper and cricket bats.

A large number of organic compounds have been suggested as stomach insecticides. It is not possible here to give detailed description of these compounds. One of the first so used was dinitro-O-creosol. Although this compound and its alkali salts are toxic to insects, they caused severe foliage injury and could not be used freely.

Certain dyes and dye intermediates were tested as stomach poison to moth-proof wool. In 1921 Mechbach observed that cloth dyed with Martin's yellow was resistant to attack to moth larva. This observation started the dye manufacturers in Germany on an extensive investigations and as a result, a number of compounds usually designated as "Eulans" were discovered. Although these compounds were effective moth-proofing agents, they were ineffective against crop eating insects.

Hexachloroethane has been used as a mosquito control measure in France. It is non-toxic to man and higher animals. The powder is blown on the surface of stagnant water in which mosquito larvae are located.

Contact Poisons

Preparations made from tobacco plant have been used as contact insecticide for a long time. Both water extracts and powdered leaves were used. It exhibits high degree of toxicity against certain species of insects, particularly the aphids. This is one of the most valuable and widely used contact poisons.

Pyrethrum powder is very much used against household insects where an insecticide non-toxic to warm blooded animals is particularly desirable. Kerosene extracts of pyrethrum appeared in market in 1916 and found extensive use as a spray, particularly against household flies and mosquitoes. The insecticidal principle in pyrethrum is found in flower head of certain plants of chrysanthemum genus—family compositae.

The insecticidal properties of pyrethrum is due to chemical compounds known as pyrethrin I and pyrethrin II.

Invaluable to man in his fight against insects are plants which contain rotenone and allied compounds. Formerly such plant decoction was used as fish poison. Rotenone and related substances are, like pyrethrum, relatively harmless to warm blooded animal and, at the same time, are very toxic to insects. They have practically no harmful effect on plants to which they are applied. Both pyrethrum and rotenone are in many respects ideal insecticides.

Rotenone bearing plants are found in tropical countries including tropical America. They belong to family leguminosae. The most important rotenone bearing plants are Derris and Lonchocarpus.

The first synthetic organic compound originally marketed as substitute for pyrethrum for using against houseflies was 2-butoxy 2-thiocyano diethyl ether, sold under the designation 'Lethane 384'. Many thio and iso-thio cyanate compounds were prepared hereafter, but most of them never came into commercial use.

One of the most fascinating subjects in the study of insects poisons is synergism which means the co-operative action of certain agencies in such a manner that the total effect is greater than the sum of the two effects taken independently. Synergism was first brought into attention in 1934 in a patent issued to Foulton who claimed that addition of 0.25 to 0.1 per cent by weight of rotenone to a kerosene pyrethrum extract increased the toxicity to a degree greater than if its effects were merely addition. Hence, rotenone here acted as synergism for pyrethrum.

The first synthetic compound used as a synergist in the kerosene pyrethrum fly spray was isobutyl undecylene amide called IN 930 which, mixed with pyrethrum extract, is sold as pyrin.

The mode of action of synergism in connection with insecticide should provide a fertile field for research for physiologist and toxicologist.

The action of synergism is usually highly specific, that is, a product which is synergist for pyrethrum is not necessarily a synergist for rotenone or other insecticides. Moreover, a combination such as IN 930 which shows greatly synergized action against housefly may fail absolutely to show such action against another insect.

The most recent method of applying insecticide is the use of freon gas as solvent and propellant. This method gives an improved result compared with those obtained with the oil base insect-spray commonly used to combat household insects The old type sprays applied by ordinary means settle very rapidly and unless the insects are actually hit by the insecticide at the time of application, they fail to be effective Freon gas which is liquid under pressure produces a floating fog that spreads to all parts of the enclosures and reaches every insects, when released. The floating suspensions are called insecticidal aerosol. They can be prepared by several methods, but the release of a solution of a insecticide in a liquified freon gas through a small capillary or nozzle has proved highly satisfactory As the highly volatile solvent reaches atmosphere, it boils vigorously and violently and distribute the insecticide in the form of fine suspension. This aerosol bomb has found an extensive use recently during the war. A soldier often is found to carry a pocket bomb or sprayer containing solution of insecticide in freon By the use of it, he makes his residence free of mosquitoes, thus eliminating the chance of having mosquito bites

It has been found by entomologist that repeated application of chemical control of insects results in an unintended artificial selection of those mutants within the pest population, which happen to be resistant to the poison used. The progeny of these mutants multiply and eventually result in the whole races of pests immune or virtually immune against chemical insecticides

In selection of an insecticide and also in determining the concentration to be employed, one must be careful Both should be so chosen that it is fatal to phytophagus insects and at the same time it is harmless to carnivorous or parasitic insect which themselves prey on the pests

Natural insect killers are practically impossible to get during war time Discovery of any synthetic compound which may be an ideal insecticide is always welcome, and D D.T , the recent synthetic insecticide, "is the war's greatest contribution to the future health of the world". Chemically, it is known as dichloro diphenyl trichloroethane.

For centuries, disease carrying insects such as flea, fly, louse, mosquito, have been one of man's constant menace. Against D.D T. they stand practically no chance of survival. D.D.T. hopes to drive off the scourges of malaria, yellow fever, dengue, filariasis, typhus and relapsing fever, leishmaniasis, yawn, trypanosomiasis, plague etc. Thus it would save at least 5,000,000 lives in a year.

D.D.T. was discovered in 1874 by a German chemist, Strassbourgh but its efficacy as insecticide was not known until 1940, when J. R. Geigy Co. of Switzerland, a pioneer in the manufacture of synthetic insecticides, discovered it to be a very useful insecticide against dairy and stable flies. The Swiss Co. promptly used this compound as active ingredient in the commercial product named as 'Gesarol'.

Although the credit of discovery of D D.T as insecticide undoubtedly goes to the Swiss workers, its use was, however, limited at that time. Its use as insecticide practically against all types of insects was worked out gradually in the Orlando Laboratory In this laboratory it was first proved to be an effective insecticide against lice which is the Army's No 1 insect enemy Gradually, a large number of tests were carried out and D D T was found to be toxic against any insect Its most important disadvantages are the facts that it is a slow killer and it has no repellent action True, it kills insects but it cannot knock down the insects instantly nor it can keep the insects away D D T attacks the nervous system of the insects After contact, flies, mosquitoes become paralyzed—and die slowly The time taken by D D T to kill depends on the individual insect as well as on the species involved. Flies and mosquitoes die within half-an-hour, bed-bug in few hours and cockroaches within a week.

The history of mosquito insecticide can be roughly divided into three following groups —

(a) Kerosene oil era (1900—1923) ,

(b) Paris Green, rotenone and pyrethrum era (1923—1943) ,

(c) D D.T era

The difficulty with kerosene is that large quantity of oil is required to have an effect. About 30-50 gallons of kerosene are required where 2 quarts of 5 per cent D D T solution can do the job

Paris Green, though safe, has no residual properties nor it has a high degree of killing power. Furthermore, it is ineffective against adult mosquitoes D D.T is twentyfive times more toxic than Paris Green to mosquito larvae.

Pyrethrum, the best insecticide prior to the discovery of D D T , has the serious disadvantage that the plantations are limited , the plants are grown mostly in Formosa and coastal China. D.D.T., being a synthetic product, can be prepared at any time. Moreover, D D T is more lethal than pyrethrum to flies, equally so to mosquitoes. Pyrethrum has the quick knock-down property, but D.D.T. compensates this drawback in its incredible residual property.

D.D.T. is applied as solution in oil, as suspension, as emulsion or as dust.

Against flies and mosquitoes in room, 5 per cent D.D.T. solution in oil is effective. It should be applied as droplet spray on ceilings, walls, screens, furniture, in fact wherever the insect could rest Fire or flame should be avoided. All food and vegetables must be carefully covered The 10 per cent oil solution is effective against fleas and cockroaches.

D D.T is effective against moths; woolens and furs can be protected by dusting with 5 per cent D D.T. powder. It kills the larvae of cloth moths almost instantly. 5 per cent D D T dust will keep dogs free from fleas, lice, ticks etc

It has been told before that D D T. is not a repellent. Even though a person has been dusted, or the room is sprayed with it, a mosquito may bite the person before the action of D D T begins on the mosquito. D.D T therefore, has to be mixed up with quick paralyzing agent in order to be more effective For this purpose, it is usually mixed up with pyrethrum

About 100,000,000 people in India suffer from malaria annually Malaria is thus causing a serious economic loss and eradication of this disease would no doubt convert this poor country into the most prosperous one in the world

Attempts to control malaria by drug treatments have failed because of lack of therapeutic agents capable of acting as true prophylactic Only alternative effective method now is to control the larval or adult stages of mosquitoes through proper drainage, oiling, dusting with Paris Green, and use of pyrethrum sprays Brilliant results of anti-mosquito campaign, in the canal zone, the Malayan States and Brazil have demonstrated their value

D D T. has an immense possibility in India as mosquito insecticide The preparation of D D T is easy All the raw materials are available in India Only difficulty in the manufacture consists in having a suitable reaction vessel which can resist the action of chlorine and sulphuric acid Glass-lined retorts would be most suitable.

Series of work have been carried out in our research laboratory The full details of work will be published elsewhere A summary of results obtained so far is given here

1. *p*-chlorobenzene is prepared by chlorinating benzene in presence of catalyst and light A series of experiment using different catalysts were studied and the maximum yield obtained is 70 per cent of the theoretical by using Fe-$FeCl_3$ catalyst.
2. Chloral hydrate is manufactured by chlorinating absolute alcohol This reaction has been studied at different temperatures in presence of different catalysts We obtained a yield of 40 per cent of theoretical
3. The reaction between chloral hydrate and *p*-chlorobenzene has been studied in different condensing agents and at different temperatures We have so far obtained yields varying from 80-90 per cent (theoretical) or crude D D T having setting point varying from 85-88°C and melting point 85-95°C

From the data obtained in our laboratory, it appears that, based on 80 per cent yield of D.D T from chloral hydrate and chlorobenzene, the material cost amounts approximately to Rs 6/- per lb This figure, of course, does not take into account the possible utility of spent sulphuric acid If sulphuric acid could be utilized the cost will come down to Rs 2/- per pound

It may be mentioned here that cost of material for producing one pound of D D T in U. S A is approximately $0 40, without taking into consideration the possible utilization of spent acid. It will, therefore, be difficult for Indian manufacturers to compete with the American manufacturers unless we obtain all the raw materials at much cheaper rates.

MEDICINE AND PUBLIC HEALTH

MEDICAL RESEARCH IN U. S. S. R.

EXCHANGE of information on certain aspects of medical research with Russian medical scientists, was the main object of a medical research mission from U. S. A., Great Britain and Canada who in January, 1944 visited Soviet Union. Vannever Bush, director or scientific research and development, U. S. A., appointed the mission.

A report of the American representatives of the mission now released (*Science*, *103*, 605, 1946) states that "Our discussion with Soviet scientists were carried out freely and informally as scientist with scientist." In all 18 medical institutions (including 8 research institutes, 3 hospitals and one medical school) were visited.

In 1941, there were 223 separate institutes in which medical research was carried out in the soviet union, with a staff of 19,000 scientific workers. The Ministry of Public Health is the chief authority in all matters pertaining to the training of physicians, dentists, nurses, medical assistants, to the allocation of personnel and hospitals, polyclinics, and to the medical relief, sanitation and prophylactic measures among population. It supervises the production of drugs and biologicals, medical instruments, spectacles and has its own publishing house for medical books and journals.

Included in the ministry are 12 Central Institutes for research *viz.*, (1) Tuberculosis, (2) Skin and Venereal diseases, (3) Microbiology and Epidemiology, (4) Oncology, (5) Neurosurgery, (6) Endocrinology, (7) Otolaryngology, (8) Opthalmology, (9) Plague, (10) Malaria and Tropical diseases, (11) Obstetrics and Gynaecology and (12) Pediatrics.

In addition, there are 51 medical, 21 stomatologic and pharmacologic and 11 post-graduate institutes where scientific research in addition to teaching work is carried on. The Soviet educational system has a primary education of 7 years, followed by 3 years in middle schools and 6 years of medical curriculum that follows in general the American plan.

The "Academy of Medical Science" organized in 1944 has 60 founding members and has sections on (1) medico-biological sciences, (2) hygiene, microbiology and epidemiology and (3) clinical medicine.

Following is a brief account of visits to individual laboratories and hospitals and of the lines along which medical research is being continued at Soviet Union (*Science*, *103*, 605, 1946).

Blood tranfusion and Blood Substitutes: The Central Institute of Hematology and Blood transfusion has 6 affiliated institutions, 72 large collecting stations and small collecting stations numbering over 1,400. The Central Institute averaged 750 blood collections per day and 800 tons of blood had been supplied to the army by 1944. Over 80 per cent of the blood collected was supplied to the army in the form of whole blood. About 20 per cent of the blood was processed and distributed as plasma or serum.

At one of the hospitals, Cadever blood was collected, within 3 to 4 hours after death, that supplied the needs of the hospital.

Insecticides and disinfectants. To impregnate external clothing against ticks and flying insects, a preparation known as '8502' consisting of 25 per cent of tetrachlorphenol, 25 per cent para-oxychlor-diphenyl and 50 per cent emulsifier has been developed. A new method of general disinfection, particularly of water is described.

Penicillin. 93 strains of molds gathered mostly from damp air-raid shelters, were investigated. One of the cultures, identified as *Penicillium crustosum*, was an active anti-biotic producer. Of the 179 cases of sepsis and infected wounds, treated with penicillin, 160 recovered, 7 died and no effect noted on 12. This culture is later identified as *P. notatum* in America but the product is apparently somewhat different.

Neuro-surgery. The main problem in infected brain injuries was how to combat the complicated mixture of contaminating bacteria associated with such wounds. It is reported that intracerotid injection of sulfapyridine was effective in meningitis, meningo-encephalitis and brain abscess.

Nutrition and Vitamins. A daily intake of 25 mg. of ascorbic acid per person is the goal towards which soviet people are working. Use of polar vegetables are also being investigated. Biochemical experiments on plant genetics, particularly wheat and barley, showed correlation between productiveness and hardiness of grain and this was used as an index in further crosses between strains to improve the grain.

DIET SURVEY

SCHOOL and pre-school children, infants, nursing and pregnant mothers are particularly vulnerable to

the ill effects of diets deficient in quantity or quality The Indian Research Fund Association undertook a "Diet Survey in School and College hostels in Delhi," (*Special Report, I R F A. No. 14,* January, 1946—price Re. 1/-) with a view to discover the defects in diets, if any, and to indicate the change and improvements necessary from the stand point of nutrition.

Enquiry was conducted for seven days in the morning and in the evening, in both boys and girls, schools and colleges At each visit uncooked food was weighed before cooking Intake of calories, proximate principles, various mineral elements, vitamins and intake of the principal foodstuffs per consumption unit have been worked out

The results obtained after a careful study of the intake of principal foodstuffs in the various groups (table III to VI) indicate that (*i*) wheat is the main item in the diet of all the groups, (*ii*) the intake of milk and milk products was reasonably high in the case of boys and girls of colleges The figure 21 oz consumption unit per day as recommended by the United Nations Conference on Food and Agriculture was reached by one group only, (*iii*) in the case of school children the amount of milk and fat intake was very small and low, (*iv*) the intake of leafy vegetables in all the groups was very small, (*v*) the diets are inadequate in respect of fruits in all the groups excepting one or two groups in the Lady Hardinge College, where the desired quantity is supplied

Mean calorie intake per consumption unit per day ranges from 2,142 to 2,693 in school children and 2,447 to 3,935 in college students The calorie intake of school children is thus below the required modern standards.

Intake of calories (mineral salts) is adequate in college hostels but is below normal in school children. It is recommended that where economic consideration make the supply of milk impossible, administration of calcium lactate (0 5 gm per day) would supply the inadequacy to some extent

The fat consumed in these hostel is *Dalda,* etc , which is of vegetable origin, and consequently they do not supply vitamin A Milk and milk products are not easily available for high price At least one pint per head per day should be aimed at. Intake of animal protein (meat, fish, poultry or egg) in some groups is nil or inadequate The inclusion of animal protein in the diet of growing children is very desirable Vitamin B_1 and B_2 is adequate in almost all the groups The intake of some uncooked green vegetables should be encouraged for a supply of vitamin C and carotene (pro-vitamin A) Green leafy vegetables are cheap and highly nutritious but the modern youths have lost taste from leafy vegetable dishes and this should be reintroduced

Other recommendations made in the pamphlet refer to number of meals, preparation and cooking of foodstuffs, management of messes etc

The author recommends the constitution of "Delhi University Food Committee" to combat ignorance, prejudice, and superstition about diet amongst students Such a Committee will enable educational authorities to start a campaign for the improvement of the dietary of school children and college boys and girls Similar diet survey of hostels under other universities in India should also be conducted We commend this useful pamphlet to the university authorities who in collaboration with stewards and managers of hostel may constitute "Food Committee" for introducing rational diets amongst our growing boys and girls consistent with the low economic standard of the vast majority

ON THE PRODUCTION OF STREPTOMYCIN I. SELECTION OF MEDIA

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STREPTOMYCIN was isolated by Waksman and Schatz[1] in 1945 from the culture fluid of *Actinomyces griseus*, and its origin, nature and properties were studied by them This antibiotic is basic in nature and active against most of the gram positive and gram negative bacteria, on which penicillin or sulpha drugs have little or no action It has been found to be active *in vitro* and *in vivo* against typhoid-coli and dysentery group of organisms, *Mycobacterium tuberculosis*, *Bacillus anthracis*, *Brucella abortus*, *Pasteurella pestis*, and also against haemophilus group It is not absorbed appreciably from the intestine, although it exerts its local action in an alkaline medium in the gut and reduces the number of microbic population

Streptomycin has been successfully administered parenterally in human subjects without any toxic effects in the infections of urinary tracts, typhoid, tularaemia and klebsiella infections, but no definite conclusion has been arrived at regarding its action in tuberculosis and brucellosis Antibacterial activity was, however, found by the authors to be inhibited *in vitro* by a low *p*H, by the presence of glucose, cysteine and 2-aminoethanethiol and, to a limited degree, by thioglycollic acid In the study of animal inoculation the toxicity of streptomycin was found to be extremely low, but unfavourable histamin like substances have been found as an impurity

While studying the optimum conditions for the production of such a useful antibiotic, consideration and selection of a proper medium is important and this forms the subject matter of the present paper The medium has been worked out from the point of view of maximum yield of streptomycin as determined by the assay described hereafter This study might be of some help to workers in India and abroad

EXPERIMENTS

Strain A strain of *Actinomyces griseus* was kindly supplied by Dr Dharmendra, Officer in Charge, Leprosy Department, School of Tropical Medicine, Calcutta This was originally received from the National Type Culture Collection, Lister Institute, England. The strain was maintained in Sabouraud's medium (with glucose) and showed when old the production of white spores on the surface Similar spores appeared when the culture was maintained in glucose agar slopes

Media. For the growth of the fungus and production of streptomycin the following medium was finally recommended by Waksman *et al* (1945)

Glucose	10 gm
Peptone	5 gm
Meat extract	5 gm
NaCl	5 gm
Tap water	. 1000 ml
Final *p*H	6 5—7 0

Corn steep liquor may also be used as a substitute for meat extract Nitrogen and carbon sources were found to be non-specific, starch and glycerol being satisfactory substitute for glucose, also casein, (hydrolyzed or without hydrolysis) various tryptones, amino acids and sodium nitrate were found to be as effective as peptone

Waksman's original medium did not give satisfactory growth of *A griseus*, and the production of streptomycin in the culture fluid was poor Therefore, some other media were tried with a view to getting a good growth and satisfactory formation of streptomycin

The following media were found to be useful and their compositions are given below The *p*H of the media in all cases was 6 8

A *Waksman's medium* (Glucose broth)

B In this meat extract was omitted and 10 per cent straw infusion was substituted for tap water Straw was cut into small pieces and 100 gms. of it were soaked in 1 litre of tap water and kept in a boiling water bath for one hour It was then extracted in a cold chamber overnight and filtered after decantation

Straw infusion helped the production of aerial mycelia with spores and formation of a pellicle, rapidly.

C. Addition of 0 6 per cent sodium nitrate to medium B. as an additional source of inorganic nitrogen. This also helped in the formation of aerial mycelia with white spores In this medium the pellicle became thinner and spores powdery.

D An attempt was made to replace organic nitrogen, by inorganic nitrogen, by putting 0 6 per cent sodium nitrate and 1 per cent glucose in 10 per cent straw infusion This is preferable as there would be a minimum quantity of organic substance in the medium which would facilitate the concentration and isolation of the antibiotic.

E. Czapek-Dox medium (with 3 per cent sucrose and 0 6 per cent sodium nitrate)

F. In this 1 per cent peptone was added to Czapek-Dox medium prepared in 10 per cent straw infusion

G This is same as F except that 20 gms of tryptone (Difco) was substituted for 10 gms of peptone

H Synthetic salts of Czapek-Dox were reduced to half, and 1 per cent tryptone and 2 per cent sucrose was added in 5 per cent straw infusion

I Sodium nitrate 0 6 per cent, tryptone 1 per cent and sucrose 2 per cent was added in 10 per cent straw infusion.

J Same as G but 1 per cent peptone was substituted for tryptone

K This medium was composed of casein digested with papain at *p*H 6 at a temperature of 55°C for 6 hours (150 gms of fat free casein was mixed with 1000 c c of distilled water containing 6 gms of activated papain) To 500 c c of this digest 500 c c of 10 per cent straw infusion 5 gms of sodium chloride and 10 gms of glucose were added and sterilized at 10 lbs pressure for ½ hour, after adjustment of *p*H

Use of carbohydrate in the medium At first glucose was selected to be used as a carbohydrate and 10 gms of it per litre were used in the media Glucose is utilized by the fungus fully during the first week of incubation and helps in the satisfactory growth of the fungus

As a trial experiment for the selection of a better carbon source, 3 per cent sucrose was substituted for 1 per cent glucose With this the growth of the fungus was slightly delayed in some cases as compared with glucose It was also observed that in some samples there was a trace of residual sugar at the end of incubation and this is why sucrose was reduced to 2 per cent in the media in later experiments Although with sucrose initially there was slight delay in the growth of the fungus, the final growth was quite satisfactory. Moreover, the result with sucrose in the medium was slightly better than with glucose, as was marked by a rise in the antibiotic titre

Use of nitrogenous substance Peptone with meat extract (Waksman), peptone, tryptone, casein peptone in combination with straw infusion have been used as source of organic nitrogenous substance It is definite that tryptone or casein peptone in combination with straw infusion improved the growth of the fungus qualitatively and quantitatively associated with proportionate increase in the antibiotic titre.

Organic nitrogen in the media might make the isolation of streptomycin difficult, and sodium nitrate was tried as a source of inorganic nitrogen with straw infusion, growth of the fungus was satisfactory, but the development of antibiotic substance was not satisfactory with this combination

Cultural method Stationary surface culture method has only been followed and shake culture method has not been included in this work Test tubes of 6″ × 1″ in diameter were used for seed tubes in the first generation Sufficient broth was put in these tubes to give a depth of at least one inch The seed tubes containing sterile broth were inoculated with spores of *A griseus* from Sabouraud's tubes The formation of surface pellicle was observed on the third or fourth day of incubation The second generation was continued in 250 c c Erlenmyer flasks containing 100 c c of media After two weeks' incubation, surface growths from three or four seed tubes were transplanted in the flask At the termination of the period of incubation, which varied from 12 to 15 days, the whole of the surface growth of the second generation in the 250 c c flask was divided and distributed in three similar flasks containing the same media to continue the third generation Subsequent generations were continued in a similar manner or by inoculation of culture emulsion and thus the propagation was continued in more flasks as was necessary

Growth of surface culture In properly selected media a thin membrane formed on the surface within a period of three days after inoculation, with sporulating greyish-green or white aerial hyphae This membrane gradually became thicker and was covered with a thicker layer of sporulating hyphae. The undersurface of a good mat showed a dark greenish-brown surface covered with a slimy gelatinous substance

Colour of spores In media containing tryptone or casein peptone, aerial mycelia bore typical grey-green spores of *A griseus* This colour lasted for about 4 or 5 days and gradually became light brown In straw infusion nutrient broth or other media, very light grey or white spores were obtained but they also became light brown in due course of time

Incubation In the preliminary experiments, cultures were incubated at room temperature, but later on better results were obtained when the flasks were incubated at 25°C

Changes in the media In most of the cases the culture fluid remained clear and transparent throughout the period of incubation It gradually became darker and alkaline in reaction. Media in a few flasks showing initial turbidity became acid in the beginning but later became clear and alkaline in

reaction Growths from these flasks were rejected and were not utilized for re-inoculations Samples of culture fluid were assayed for their antibiotic activities after collecting and centrifuging them aseptically Assaying was done every day from the 10th day onward upto the 14th day. The maximum antibiotic activity was usually found on the 12th day of incubation. Samples were also tested for reaction and determination of residual sugar if any

Importance of specificity of an active strain of *A. griseus* has been stressed by Schatz and Waksman[2] in the role of the production of streptomycin It has been pointed out by them that sporulated surface growths with white or preferably greyish-green mycelia are characteristics of an active culture, producing a maximum quantity of streptomycin, in contrast to surface cultures with few or no spores which might be totally inactive According to Schatz and Waksman, an active strain shows on surface culture aerial mycelia with a large number of spores, utilizes glucose rapidly at the end of the 5th or 6th day of incubation, makes the medium steadily alkaline and gives a filtrate active against *E. Coli*, *B subtilis* etc. Such a strain is also resistant to streptomycin Whereas an inactive strain on surface culture shows scanty development of spores, slow utilization of sugar, formation of acid in the medium, and makes the medium thicker by formation of a gummy substance Such cultures yield a fluid with little antibiotic activity and is not resistant to streptomycin. The authors have also described how, from an inactive strain, a sporulating active strain can be isolated by plating.

By making certain alterations in the media it was possible to get characteristically active growth from a partially active one and finally in tryptone media with Czapek-Dox synthetic salts, a growth like that of an active strain with greyish-green spores could be obtained and the characters of the growth could be maintained in the same media without any fall in the antibiotic titre When such growth was transplanted in glucose broth of Waksman, the growth was poor For example, an extreme case may be cited A surface culture in Waksman's glucose broth showed a smooth glistening surface without formation of any visible spores The antibiotic activity was also poor and as usual the titre fell after reaching the maximum This growth was transferred to a flask containing Waksman's medium with straw infusion (Medium B) and showed development of heavily sporulating white aerial mycelia. This growth, when transferred to the same medium B, maintained the character, but, when transferred to tryptone synthetic or casein peptone media, there was a growth with heavily sporulated greyish-green aerial mycelia and the antibiotic titre also rose to a maximum in the culture fluid.

Method of assay. A known strain *E coli* was

TABLE I

THE GROWTH OF *A griseus* IN DIFFERENT MEDIA AND THE DEVELOPMENT OF ANTIBIOTIC SUBSTANCE

Media	Character of the surface growth	Character of Spores of the surface of growth	Final *p*H	Day of appearance of highest antibiotic type	Maximum dilution in which there are inhibition of *E coli* (dilution units per c c)
A	Thin membrane	Isolated areas of white spores	8 2	12th-13th day	31
B (*a*)	Slight thicker membrane	A uniform layer of white spores	8 4	12th-13th day	35—160
C (*a*)	Same as in B but the membrane are more friable	Powdery white spores	7 2	11th-12th day	55—100
D (*a*)	No continuous membrane was formed	Powdery white spores	6 2	12th day	31
E	Slow scanty growth which was thin and friable	Powdery white spores	7 0	up to 18 days	nil
F	Thin membranous growth	White or light brown spores	8 2	11th day	55
G	Thick, tough membrane	A uniform layer of grey green spores	8 2	12th day	160—235
H	,, ,,	,,	7 6	12th day	160—235
I	Thin membrane	Light brown spores	8 2	11th day	100—160
J	,, ,,	,, ,, ,,	8 2	11th day	55
K (*a*)	Thick, tough membrane	Typical grey-green spores.	7 6	12th day	235

(*a*) Similar experiments were carried out substituting 2 to 3 per cent sucrose in place of 1% glucose and similar or slightly better results were obtained by increase in the titre of the antibiotic activity.

used as a test organism to determine the quantitative standard for the study of production of streptomycin Unit of streptomycin, as originally described by Waksman, is the minimum amount of material which when present in 1 c c. of nutrient broth will just inhibit the growth of a known strain of *E coli* The culture fluid was aseptically centrifuged to settle the fine particles of the fungus that were in suspension Bacterial filtration through L 3 candles was avoided, because in the course of investigation it was found that when the culture fluid containing streptomycin was passed through these candles, most of the active material was adsorbed and the titre of antibacterial activity fell to a minimum after filtration. 4 5 c c of nutrient broth at *p*H 7 6 were distributed in 5″ × ⅝″ test tubes (oxidizable matter 0 5 per cent) and sterilized A serial dilution of the culture fluid was done in these broth tubes and the tubes were then inoculated with a drop of fluid (04 c c) containing a suspension of *E coli* For this suspension 0 05 c c of a 24 hours' old culture in broth was diluted in 10 c c of normal saline This inoculum was quite sufficient to show growth in the control tubes in 18 hours, when there was a uniform turbidity in the tube. The tubes that did not show any haziness or turbidity were considered to inhibit the growth of the organism. Readings were taken after 18 to 20 hours' incubation at room temperature.

Table I shows the growth of *A griseus* in different media and the development of antibiotic substance

Further work is in progress and an attempt has been made to isolate streptomycin as water insoluble helianthate salt which will from the subject matter of a subsequent paper.

My grateful thanks are due to Dr D M Bose, Director, Bose Research Institute, Calcutta, for giving his kind and valuable suggestions and facilities for carrying out the experiments

My thanks are also due to Dr Dharmendra, Officer-in-charge, Leprosy department, School of Tropical Medicine, Calcutta, for kindly helping me with the strain of *A griseus*

References

[1] Waksman, S A and Schatz, A, *Journ Amer Pharm Assoc*, Scientific Edition, 34, 273, 1945
[2] Schatz, A and Waksman, S A, *Proc Nat Acad Sci*, *31*, 129, 1945.

BOOK REVIEWS

Chromosome Atlas of Cultivated Plants—By C. D. Darlington and E K Janaki Ammal. George Allen and Unwin Ltd, 1945. Pp 397. Price 12*s*. 6*d*.

The authors are to be congratulated in having brought out this book which will be of great help to cytologists and plant-breeders alike. Tischler's and Gaiser's works not being generally available this book will remove a long felt want and is sure to find a place in all agricultural and botanical institutions.

The book opens with an admirable introduction on the origin of cultivated plants by C D. Darlington, in which he discusses the centres of origin of cultivated plants, their evolution by cultivation and the invention of plant breeding This is followed by a section in which the authors point out the importance of the chromosomes in the development and evolution of cultivated plants. The importance of polyploidy and other chromosome changes leading to the formation of genetic species as also the bearing of chromosome numbers on the classification of plants have been elucidated with examples

The families of Angiosperms have been mainly arranged according to Hutchinson's system of classification, while those of Gymnosperms follow Engler and Gilg's system. The diploid number has been given in all cases followed by the name of the author, the economic importance of the plants and their distribution The incorporation of these latter features has considerably enhanced the value of the book

It is remarkable that in a comprehensive work of this nature there is hardly any omission. A case in point, however, is *Trichosanthes* dioica (*Ind Jour Agri. Sci.*, 7, 497-510, 1937).

It would have been better if the authors could have also given the earlier references as well as the latest. The book can be unreservedly recommended to all advanced students of botany.

I. B.

Directiveness of Organic Activities—E. S Russel, O B S, D Sc, F L S, Published by the Cambridge University Press. Price 8s 6d. net

The author in the preface says "the book is an experiment or adventure in biological thought" which aptly describes it. Not being fully satisfied with the mechanistic (and also the vitalistic) points of view in explaining the orderly working of the living organism the author has, even at the risk of being called a teleologist, attempted to work out a method in biology, which though attractive is heterodox

According to the author the central concept of functional biology must be organism and not mechanism and the unstable and self regulating organisation reached in the development of a living organism is something totally different from the stable equilibrium, which is the endstate of an inorganic system The vast masses of facts of biochemistry and biophysics must be correlated in terms of organic activity in explaining their function and their relation to biological ends To differentiate and to make this more clear the author has stressed on the "Directive activity"—actions directed towards endstates or goals, which are normally related to the biological ends of self maintainance, development and reproduction Dr Russel has tried to explain this characteristic of directiveness (or purposiveness) in the activities of organisms by illustrating with the help of examples selected from different status of life

The author's view of regarding the manifestations of life as a whole is also the expressed view of many eminent biologists and he rightly lays stress on this point. One is apt to overlook this when dealing in details The book is very interesting reading with clearly explained instances from various levels and conditions of life.

B. B. S.

Text Book of Histology for Medical Students—Evelyn E Hewer, D Sc (Lond)—Third Edition (Reprint) Published by William Heineman Medical Books Ltd, London. 1945 Price 17s 6d net

This Text Book of Histology is admirably suitable for students of Physiology and Medicine Printed on good art paper the illustrations have been well executed A special feature of the book is the large number of very fine microphotographs The students will find this very useful as these are true representations of what they will actually see under the microscope A short account of the variations of structure under different physiological conditions has been added at the end of each chapter, which will also prove useful The structures of tissues and organs have been well described without going into intimate details

B B S

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

GROWING FODDER CROPS ON SEWAGE

Sewage is a rich source of plant food and its hygienic and economic utilisation in agriculture has been a problem of very considerable interest all over the World We have carried out some investigations on sewage farming under the auspices of the Imperial Council of Agricultural Research and considering the results of our studies (given in a series of reports to the Council) from a practical angle, it would appear that production of fodder is perhaps the safest and the best use that can be made of sewage At the same time, there are certain related aspects which would require the careful consideration of the agricultural and health authorities, *e.g.*, the area available and its proportion to the total normal discharge of sewage ; distance from town, the slope of the land, the mechanical composition and drainage facilities of the soil, the water table and in certain places, the nature of sub-soil water ; the facilities for the discharge of storm water ; the direction of wind in different seasons ; the nature and extent of pre-treatment of sewage with particular reference to the destruction or elimination of fly and mosquito larvae, hook-worm and other undesirable forms of life ; the efficiency of oxidation of sewage organic matter and the associated microbial forms ; and the local arrangements for the disposal of night-soil and refuse. In the choice of the site and location of the sewage farms, in the proper management of the farms and related matters, the Agricultural and Health Departments in the Provinces should give the best possible advice and assistance.

The present trends of evidence in regard to the use of sewage for farming purposes would suggest

that it gives the best response only after dilution, that the soil requires liming and periodical rest. It is not always possible to dilute sewage, but, more recently we have found that the basin below a sewage irrigated area usually holds an abundant quantity of water suitable for dilution. This would offer very attractive possibilities because, by installing a few bore-wells or dug wells in the sewage farm area, it would be possible both to suitably dilute the sewage and to extend the area under fodder crops. If suitably treated and diluted, even other types of crops can be grown on sewage. In this direction the co-operation of the Departments of Industries, with their expert staff in well boring, will be most useful.

In the neighbourhood of many towns, the present tendency is to grow market garden crops which fetch a quick cash return. Our experience has shown that such crops are not always dependable. Leafy crops usually do fairly well, but even these harbour heavy superficial pollution which could not be completely destroyed by ordinary cooking. These pollutions may not have any immediate harmful effect, but they will produce digestive and other disorders in the long run. Crops grown on sewage usually contain excessive amount of water and tend to perish rapidly on standing.

From the point of view of cash return, grass will, in the long run be as profitable as, if not more than, market garden crops. Certain grasses are very heavy yielders (50 to 60 tons per acre or more) and several cuttings can be taken in a year. In any town, there is always an assured clientale for green grass. The city of Madura is running quite a successful farm on grass and has scope for making a still bigger success of it. Certain progressive municipalities can also maintain their own herd of milch and drought cattle on their own farm. Animals are quite resistant to sewage pollution, so, they can be safely reared on sewage-grown fodder.

Sugarcane can be grown on sewage and under favourable conditions, quite heavy yields (75 to 85 tons) can be obtained. Unlike the fodder crops sugarcane requires much attention. The juice contains the expected quantity of sugar, but it also includes certain salts which somewhat affect both the taste and the setting quality if made into *gur* (jaggery). The presence of salts does not affect the manufacture of white sugar, but this would not be possible unless there is a factory in the neighbourhood. The possibility of growing sugarcane still requires careful consideration because of its value as a good cash crop.

The Imperial Council of Agricultural Research is maintaining a research unit at Bangalore for the study of problems in sewage farming. Apart from the related fundamental studies, this unit has also carried out work at a few select centres for utilising not only domestic sewage but also industrial wastes (mixed with domestic sewage) for crop production.

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Bangalore, 2-5-1946.

ON INTEGER CUBE ROOTS OF THE UNIT MATRIX

VAIDYANATHASWAMY's paper[1] has led us to conjecture that:

Let p denote a prime. Then every integer matrix X_{p-1} of the $(p-1)$ th order, except E_{p-1} itself, and such that $X^p_{p-1}=E_{p-1}$ (the unit matrix of order $p-1$) can be expressed as

$$\Delta^{-1} M_{p-1} \Delta$$

where Δ is an integer-matrix of order $p-1$ and determinant ± 1, and $M_{p-1}=\begin{pmatrix} -1 & -1 & . & -1 \\ 1 & 0 & & 0 \\ 0 & 1 & . & 0 \\ 0 & . & 0 & 1 & 0 \end{pmatrix}$

We have proved this conjecture for $p=3$. Even in this case the proof lies fairly deep and is based on the following lemmas.

Lemma 1. If

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}^3=\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

where a, b, c, d are integers then either (i) $a=d=1$, $b=c=0$ or (ii) $a+d=-1$, $ad-bc=1$.

Lemma 2. If

$$n^2+n+1=m_1 m_2$$

then we can find integers A, B, C, D such that

$$m_1=A^2+C^2+AC,$$
$$m_2=B^2+D^2+BD,$$
$$AD-BC=1.$$

Example. We have

$$\begin{pmatrix} 7 & -3 \\ 19 & -8 \end{pmatrix}^3=\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

while

$$\begin{pmatrix} 7 & -3 \\ 19 & -8 \end{pmatrix}=\begin{pmatrix} 1 & 2 \\ 2 & 5 \end{pmatrix}\begin{pmatrix} -1 & -1 \\ 1 & 0 \end{pmatrix}\begin{pmatrix} 5 & -2 \\ -2 & 1 \end{pmatrix}$$

where the first matrix on the right-hand-side is the inverse of the third.

R. P. BAMBAH
S. CHOWLA

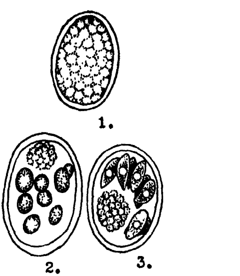
Government College,
Lahore, 19-5-1946.

[1] Vaidyanathswamy, *Jour. Lond. Math. Soc.*, 3, 1928.

ON A NEW COCCIDIUM *TYZZERIA ALLENI* N. SP. FROM THE INTESTINE OF THE BIRD COTTON-TEAL*

A SINGLE specimen of a piscivorous bird the cotton-teal *Nettapus coromandelianus* Gmelin was collected from the Bidyadhari Spill area Fisheries in the neighbourhood of Calcutta. The bird harboured in its large intestine, the oocysts of a species of coccidian parasite. On sporulation the oocysts revealed asporocystid octozoic condition, which is found in the genera *Schellackia* Reichenow, *Pfeiffernella* Wasielewski, and *Tyzzeria* Allen The latter genus was founded in 1936 to receive the type species *perniciosa*, and as far as is known this is the only species of the genus Allen[1] (1936) has pointed out the diagnostic characters of these three genera The present coccidium is not a haemogregarine as the life cycle is completed in one host, and so cannot be included in the genus *Schellackia*, while on the other hand it differs from the genus *Pfeiffernella* in having a vertebrate host Thus it agrees with the characters of the genus *Tyzzeria* and is therefore placed under this genus

The coccidium under observation differs from *Tyzzeria perniciosa* Allen, in the shape as well as size of the oocysts, in the structure of the sporozoites and other characters It is the second species of the genus and is recorded for the first time from India We propose to call it *Tyzzeria alleni* n sp, after the name of the discoverer of the genus



Tyzzeria alleni n sp. (Figs 1—3 × 1600)
FIG 1. Immature oocyst FIGS 2, 3 Sporulated oocysts

Description —The oocysts are oval in shape and the immature ones (Fig 1) are completely filled up with the zygotic mass consisting of a large number of refractile granules. They sporulated in 2·5 per cent potassium bichromate solution after 48 hours. No micropyle could be seen in the oocysts at any stage of their development. A residual body (Figs. 2 and 3) in the form of a spherical compact mass is left at one pole of the oocyst after the formation of the sporozoites The oocysts measure 14·48—17·3 $\mu \times$ 9·63—11·5μ. The residual mass is about 6·42μ in diameter

The sporozoites first appear as spherical bodies (Fig 2) but soon they assume an elongated form (Fig 3) having rounded posterior and pointed anterior ends. They measure 5·35—6·48μ in length. The nucleus is usually situated at the centre of the body of a sporozoite It is spherical in outline measuring about 2·14μ in diameter.

In the section of the small intestine of the host no intra-cellular stages could be found

Diagnosis

Systematic position—*Tyzzeria alleni* (Coccidiida, Eimeridae)

Description Oocysts oval, dimension—14·48—17·37$\mu \times$ 9·63—4·5μ, no micropyle, residuum present, sporulation time—48 hours, sporozoites elongated, 5·35—6·48μ in length, nucleus spherical.

Host *Nettapus coromandelianus* Gmelin

Location Intestine

Locality. Bidyadhari Spill area Fisheries, Calcutta

Date, 9-2-1946

One of us (S P. Basu) is greatly indebted to Prof H K Mookerjee, Sir Nilratan Professor of Zoology, Calcutta University, and to Dr S. L Hora, Director of Fisheries, Bengal, for permitting him to work in this laboratory.

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[1] Allen, E. A, *Arch f. Protistenkde*, 87, 262-67, 1936

* Published with the kind permission of the Director of Fisheries, Bengal.

ON THE DEVELOPMENT OF MICROCYCLONES BELOW THUNDER CLOUDS

THE occurrence of airmass thunderstorms in regions of relatively flat barometer gradient is well known. The first indication of their probable development is usually shown on the weather charts by

small sinuosities in the isobars which are apparently unrelated to the main isobaric field. Such irregularities are usually found on day-time charts when convection activity is well marked. They sometimes appear at several adjoining stations when isobars at smaller intervals are drawn and their occurrence in most cases constitutes a very reliable indication of localities where major thunderstorms will develop later. So far these sinuosities were regarded as mere irregularities which have become apparent with the availability of an increased number of barometer reports. That this is not always so and that such irregularities evidently represent very minor cyclonic centres or micro cyclones which accompany individual thunderstorms will be clear from the explanation given below.

The vertical acceleration of a moving element of air is given by $g\frac{\rho-\rho'}{\rho'}$ where ρ is the density of the environment and ρ' that of the moving element of air

$$\frac{dw}{dt} = w\frac{\partial w}{\partial z} = g\frac{\rho-\rho'}{\rho'}$$

$$\therefore g(\rho-\rho')\,dz = \rho' w\frac{\partial w}{\partial z}\,dz$$

The moving element of air may be regarded to form the thunder cloud with its axis vertical Then $\int_0^{2h} g(\rho'-\rho)\,dz$ represents the excess of weight of a column of unit cross section of air inside the cloud over that outside. It is taken that $2h$ is the vertical extent of the cloud

$$\int_0^{2h} g(\rho'-\rho)\,dz = -\int_0^{2h} \rho' w\frac{\partial w}{\partial z}\,dz$$

The vertical velocity is zero at the base and top of the cloud with a maximum value at height h, $\frac{\partial w}{\partial z}$ will be positive between heights zero to h and negative between h and $2h$ The density decreases with height continuously from o to $2h$. Hence it can be easily seen that $\int_0^{2h} \rho' w\frac{\partial w}{\partial z}\,dz$ is positive or $\int_0^{2h} g(\rho'-\rho)\,dz$ is negative. This effect should hence cause a pressure fall immediately below the cloud compared to the cloudless surroundings. The magnitude of this pressure fall is derived below.

Let $w=aZ$ between $Z=o$ and $Z=h$ and $w=2ah-az$ between $Z=h$ and $Z=2h$

$$\int_0^{2h} g(\rho'-\rho)\,dz = -\int_0^{2h} \rho' w\frac{\partial w}{\partial z}\,dz$$

$$= -\int_0^{h} \rho' w\frac{\partial w}{\partial z}\,dz - \int_h^{2h} \rho' w\frac{\partial w}{dz}\,dz$$

$$= -\int_0^{h} \rho' a^2 z\,dz + \int_h^{2h} \rho'(2a^2h - a^2z\;dz$$

Let ρ'_m and ρ'_n be the mean densities of the cloud air between the heights o to h and h to $2h$ respectively, $\rho'_m > \rho'_n$

$$\int_0^{2h} g(\rho'-\rho) = -\rho'_m\frac{a^2h^2}{2} + \rho'_n\frac{a^2h^2}{2}$$

$$= \tfrac{1}{2}(\rho'_n - \rho'_m)\,a^2h^2$$

But $ah = W_{max}$, W_{max} being the maximum vertical velocity.

$$\therefore \int_0^{2h} g(\rho'-\rho')\,dz = \tfrac{1}{2}(\rho'_n - \rho'_m)\,w^2_{max}$$

Assuming the standard values of density in an I C A N atmosphere, the pressure fall for different values of W_{max} and for two depths of the cloud are given below

TABLE I

Pressure fall below the thunder cloud for the depth $2h=30{,}000$ ft

$\rho'_m = 9\cdot99\times10^{-4}$ gms/cm^3

$\rho'_n = 6\cdot15\times10^{-4}$ gms/cm^3

W_{max}	Pressure fall
30 m p h	. 0 34 mbs
50 m.p.h.	... 0 96 mbs
100 m.p h	. 3 84 mbs

TABLE II

Pressure fall below the thunder cloud for the depth $2h=50{,}000$ ft.

$\rho'_m = 8\cdot88\times10^{-4}$ gms/cm^3

$\rho'_n = 3\;68\times10^{-4}$gms/cm^3

W_{max}	Pressure fall
30 m p.h	... 0 47 mbs
50 m.p h.	. . 1·30 mbs
100 m p.h	... 5 19 mbs

As is well known, the vertical velocities in an air mass thunder cloud progressively increase as one moves from the edge towards the centre of the cloud.

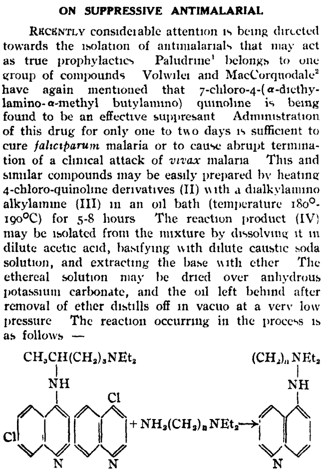
This would cause progressive pressure fall below the cloud, the maximum fall being at the centre of the cloud The total pressure fall is thus distributed over half the width of the cloud, which may vary within wide limits The magnitude of the total fall of pressure will depend upon the cloud thickness and the vertical velocity as shown above In those cases in which the horizontal extent of the cloud is small and the gradient of vertical velocity from the edges to the centre of the cloud is large, the pressure variations may show themselves on the synoptic chart as a miniature cyclone below the thunder cloud

S MULL
Y P RAO

Calcutta, 28-5-1946

ON SUPPRESSIVE ANTIMALARIAL

RECENTLY considerable attention is being directed towards the isolation of antimalarials that may act as true prophylactics Paludrine[1] belongs to one group of compounds Volwiler and MacCorquodale[2] have again mentioned that 7-chloro-4-(α-diethylamino-α-methyl butylamino) quinoline is being found to be an effective suppresant Administration of this drug for only one to two days is sufficient to cure *falciparum* malaria or to cause abrupt termination of a clinical attack of *vivax* malaria This and similar compounds may be easily prepared by heating 4-chloro-quinoline derivatives (II) with a dialkylamino alkylamine (III) in an oil bath (temperature 180°-190°C) for 5-8 hours The reaction product (IV) may be isolated from the mixture by dissolving it in dilute acetic acid, basifying with dilute caustic soda solution, and extracting the base with ether The ethereal solution may be dried over anhydrous potassium carbonate, and the oil left behind after removal of ether distills off in vacuo at a very low pressure The reaction occurring in the process is as follows —



(I) (II) (III) (IV)

The starting materials (II) and (III) may be altered by taking various derivatives of 4-chloro quinoline and taking different dialkylamino alkylamines where 'n' may be 2, 3 or 4. The above 7-chloro-4-(δ-diethylamino-α-methyl butyl) amino-quinoline (I) is obtained from 4, 7-dichloro quinoline and 1-diethylamino-4-aminopentane. It distills at 209-212°C under 0 2-0'3 mm. pressure but solidifies on cooling. This solid separates again in fine crystalline form (m p 88°C) from benzene The compound readily dissolves in dilute acids and forms insoluble salt with bis-methylene salicylic acid It is in the form of the latter salt that the drug may be issued for clinical trials in tablets.

Similar work is in progress for the isolation of suitable sulphanilamide derivatives that may also possess the property of destroying the malarial parasites at the infecting stage

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P. K. DAS GUPTA

Bengal Immunity Research Laboratory,
Calcutta, 2-6-1946.

[1] Das Gupta, Gupta and Basu, SCIENCE AND CULTURE, *11*, 704, 1946

[2] Volwiler and MacCorquodale, *Chem Eng News*, *24*, 347, 1946

THE RELATION BETWEEN THE ACID VALUES OF JUTE FIBRE AND ITS ABSORPTION OF METHYLENE BLUE

IN a preliminary short note[1] it has been shown that the affinity of jute fibre for basic dyes is not due to the presence of lignin as is generally believed Further work now indicates that it is owing to the occurrence of carboxyl groups in the holo-cellulose that jute possesses acidic properties and behaves like cotton mordanted with tannic acid so far as the absorption of basic dyes is concerned. These carboxyl groups are mostly occupied by metals like Ca, Mg, etc in the raw fibre (ash content 0 53 per cent) which has consequently a low acid value (measured in terms of milli-equivalents of NaOH neutralised by H^+ ions liberated from 100 g of bone-dry material). When the fibre is made cation-free (having only 0'08 per cent ash) by treating with sufficient decinormal HCl at room temperature for half-an-hour, its acid value increases nearly four-fold. The colour of the fibre also appreciably improves But the maximum methylene blue absorption value (expressed as millimoles of the dye taken up by 100 g. of the bone-dry material) under suitable conditions is the same in both cases and is practically equal to its acid value after dilute acid treatment

However, on treating the raw fibre with 1 per cent NaOH at room temperature for half-an-hour,

souring with N/10 HCl and washing very thoroughly with CO_2-free water, the acid value of the fibre becomes almost double, as also its dye absorption The loss in weight suffered by the fibre during this treatment is 6 15 per cent. This is important from an industrial point of view inasmuch as this simple treatment softens the fibre considerably and also largely improves its dyeing property. When all the carboxyl groups in such a fibre are blocked with sodium by repeated treatment with sodium chloride solution, the colour of the fibre darkens, the acid value falls to almost zero, but the methylene blue absorption value remains unchanged The linkage ruptured on treatment with alkali appears to be of ester type but the alcohol involved is not methanol (or ethanol) because the methoxyl value (determined by Zeisel's method) of the raw fibre is 4 00 per cent while that of the alkali treated fibre is 3 91 per cent These carboxyl groups do not wholly occur in the hemicellulose portion of the fibre because the acid value of α-cellulose obtained from jute is appreciable (about 5)

The acid value of the lignin-free holo-cellulose prepared from jute fibre by the chlorite method[2] is slightly higher than that of the alkali treated jute, so is also its dye absorption This may indicate that the hydroxyl groups of lignin are involved in the ester formation with the carboxyl groups of holo-cellulose In that case, one might readily explain why even very mild alkali pre-treatment so greatly facilitates the removal of lignin in all the common methods of cellulose estimation

The acid values were determined by the method of Neale and Stringfellow[3] as well as that of Sookne and Harris[4] The former uses solutions of NaCl and NaOH and the latter a solution of silver-*o*-nitrophenolate. Modifications were necessary in both cases for appropriate application to jute fibre It is interesting to note here that an exchange of cation takes place, silver replacing other metallic ions present, when silver-*o*-nitrophenolate is employed for the determination of acid values. The raw and the N/10 HCl washed fibre have the same acid value by this method The amount of silver bound by the fibre (as estimated in the ash) has been found to be practically the same as that disappearing from the solution. This base-binding capacity of jute is obviously responsible for its water softening action ; the alkali treated fibre being a more powerful water-softener.

Carefully purified methylene blue (all the commercial samples have been found to be impure) was used for dye absorption measurements ; the fall in concentration of methylene blue in the dye-bath was determined both by the colorimetric method and the method of Ferrey[5], using pot, dichromate solution The figures are more or less concordant. It has been found that the maximum absorption of methylene blue takes place at *p*H 7 , so methylene blue solutions of various strengths, buffered at *p*H 7 (with KH_2PO_4 and NaOH) were employed at room temperature, the time of exposure being two hours , the fibre liquor-ratio was 1 100

From the results (means of several estimations) given below it will be seen that the acid values agree fairly well with the dye absorption values, considering the fact that the system is heterogeneous It is therefore concluded that the absorption of methylene blue by jute, raw or treated, represents a double decomposition between the dye molecules and the holocellulose The methylene blue absorption values expressed in millimoles per 100 g therefore stand also for the acid values of the respective fibres.

It is to be noted that in the experiments reported in *Nature* (*loc cit*) the conditions differed as follows. Unpurified methylene blue was used , the solution was millimolar and not buffered, and the fibre liquor ratio was 1 50

J-794, a good variety of white jute, was employed.

Sample	Acid value		Absorption of methylene blue at *p*H 7 — Concentration of the dye per litre		
	(with NaCl + NaOH)	(with silver -o-nitro-phenolate)	2 5 millimoles	5 millimoles	10 millimoles
Raw jute	2 89	11 27	11 16	11 68	13 13
Jute defatted with alcohol-benzene . .	3 04	11 55	10 81	12 31	11 86
Defatted jute, N/10 HCl treated	11 70	12 33	11 57	10 12	13 32
Raw jute treated with 1% NaOH for 1 hr at room temp and then with N/10 HCl	21 21		19 01	23 85	26 71
Raw jute boiled with 2% NaOH for 2 hrs and then N/10 HCl treated	15 44	17 78	16 14	17 62	17 21
Chlorite cellulose	23 02	24 07	19 14	26 91	27 97
Cross & Bevan's cellulose	18 18	18 66	13 64	16 29	17 69
Chlorite cellulose from jute treated with 1% NaOH for ½ hr. and N/10 HCl previously	21 19	20 74	13 86	19 15	23 33
α-Cellulose from chlorite cellulose	3 95	5 07	4 46	5 22	3 60
Cellulose, again treated with 17·5% NaOH ..	3 14	3 83	—	2·46	3 74
Defatted jute, N/10 HCl treated, repeatedly washed with sodium chloride solution, and finally with water ...	0 72	12 26	10·36	11·27	10 38

Details of the experiments will be published elsewhere.

Our grateful thanks are due to Mr C R. Nodder, Director, for his kind interest in the work.

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Indian Central Jute Committee,
Calcutta, 3-6-1946.

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EFFECT OF POTASSIUM CARBONATE ON NICKEL CATALYST FOR FISCHER-TROPSCH SYNTHESIS

FISCHER and Meyer[1] prepared a nickel catalyst containing 18% thoria which catalysed at 178°C formation of higher hydrocarbons from a 2 1 (by volume) mixture of hydrogen and carbon monoxide They precipitated both nickel and thorium as carbonate on kieselguhr using potassium carbonate as the precipitant Their catalyst after reduction was found to be more active when the potassium salt was not fully washed away from the precipitate It was also found that the addition of potassium carbonate after preparation of the catalyst had a deliterious effect[2]

A previous study of nickel catalyst[3] revealed the fact that in the presence of potassium carbonate in nickel catalyst reaction

$$2CO = CO_2 + C$$

was accelerated to an undesirable extent, and as a consequence the catalyst lost its activity before long due to carbon deposition on its surface. The effect of potassium carbonate on the life of activity of the Fischer-Meyer catalyst has therefore been studied.

TABLE I

Catalyst Composition —			
Kieselguhr	46 %	Weight of reduced Catalyst taken	2·51 gm.
Nickel	45 77%	Volume of reduced Catalyst taken	3 6 c.c.
Thoria	8 3 %		
Potassium Carbonate	Traces		

Reaction Temp °C	H_2/CO by vol	S V N T P *	Vol. passed (litres at N T P)	Wt. of volatile hydrocarbon sorbed in activated carbon
178—181	1 95	0 034	4 32	0 1940 gm †
After passing 13 litres of reaction gas mixture.				
178—181	2 04	0 033	4 34	nil
On complete removal of potassium carbonate.				
178—180	2 08	0 048	4 61	0 1191 gm
After passing 14 litres of reaction gas mixture				
178—180	2·16	0 049	4 62	0 1296 gm.

* Space Velocity (S V.) = number of c cs (N.T P) of the gas mixture that passed over 1 c c of the catalyst space per second.
† Probably includes some carbon dioxide which was not previously removed in this case.

In the above table it will be seen that during passage of the first 4·32 litres of a gas mixture of carbon monoxide and hydrogen (approximately 1 . 2 by volume) about 0 1940 gm of volatile hydrocarbon was formed. But after 13 litres of the gas mixture were passed this hydrocarbon formation ceased altogether.

The deactivated catalyst was then washed with freshly redistilled water under non-oxidising conditions as far as it was practicable, until completely free from potassium carbonate. The alkali free catalyst was reduced again at 200°C before being studied for the second time

TABLE II

Catalyst Composition .—			
Kieselguhr	.. 46%	Weight of reduced Catalyst taken	1 85 gm
Nickel	. 45 73%	Volume of reduced Catalyst taken	2 0 c c.
Thoria	8 23%		
Ceria	0 0823%		
Potassium Carbonate	Traces		

Reaction Temp °C	H_2/CO by vol.	S.V. N T.P.	Vol passed (litres at N T P)	Wt. of volatile hydrocarbon sorbed in activated carbon.
178—181	1 97	0 059	4 40	0 0628 gm
After passing about 8 litres of reaction gas mixture				
189—190	2 00	0·055	4·42	nil
On complete removal of potassium carbonate.				
189—190	2 20	0 052	4·41	0·0333 gm.
219—220	2·27	0 061	4 30	0·1406 gm.

The activity being thus regenerated the catalyst was studied at 140-141, 150-151, 160-161, 170-171,

178-180, and 189-190 (°C) Its activity was negligible at the initial stage but increased gradually and remained steady when its maximum for a temperature was reached.

It is clear on the otherhand that the catalyst from which the alkali was completely removed showed more of steady activity.

In the above respects a catalyst containing ceria in addition, also behaved similarly This catalyst when freed from potassium carbonate as above on the otherhand did not lose activity even at 219°C As a matter of fact it was not much active at the temperature 178°-180°C.

From the data given above it can be concluded that whatever small activity the catalyst had, was lost quickly when traces of potassium carbonate were present The alkali free catalyst had a steady activity at 219°-220°C.

The above catalysts when they lost activity due to presence of traces of potassium carbonate, so far as hydrocarbon synthesis was concerned, began to accelerate water and carbon dioxide formation due to the reactions

$$2CO = C + CO_2$$
$$CO + H_2 = C + H_2O.$$

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Dacca, 9-6-1946.

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[3] Chakravarty, SCIENCE AND CULTURE, *3*, 396, 1938

THORIUM IN TRAVANCORE

I AM writing this to correct any misconceptions, likely to be created in the minds of your readers who have seen the note under the title mentioned above in the June (1946) issue of *Science and Culture*. The note says, "India's deposits being largely concentrated in Travancore where monazite sand and ilmenite deposits contain about 2 to 3 per cent thorium. The southernmost beaches of Travancore near Cape Comorin are covered with the sand".

The present known source of thorium is the monazite sand present in the beach deposits and other neighbouring pockets. So far, the beach deposits and adjoining lands alone have been exploited for the mining and concentration of monazite, as well as the other beach minerals, ilmenite, zircon, rutile, sillimanite and garnet Interior pockets where monazite is not unlikely to be present, have not so far as I know, been worked. It appears from the above statement quoted, that monazite sand and ilmenite deposits are two separate features whereas there are no ilmenite or monazite deposits but a deposit of beach minerals appearing in certain areas of the sea coast, containing almost all these minerals, in varying proportions and the preponderating mineral in these, is ilmenite Monazite, however, is historically the first mineral separated and exported from Travancore, but ilmenite has long overtaken monazite in its economic production and export. As one who has had opportunities of determining, not only the mineral composition of many hundreds of samples of 'mined' beach scrapings, for purposes of concentration, but also had made many field investigations in search of rich sources of monazite-bearing beach deposits in the better known regions of Manavalakurichi and Neendakara beds, I would like to state that a deposit on the beach, going 5 to 6 per cent monazite is regarded as a 'find' and is very rare, indeed Mined material containing 3 per cent monazite in certain known regions of the beach under certain conditions, is considered normal At the same time there are deposits which, for valid reasons, do not contain more than a trace of monazite It therefore appears to me that the statement that these deposits contain "2 to 3" per cent thorium is misleading, and very much off the mark Thoria-content—fortunately the atomic weight of thorium is very high and so the calculation of elemental thorium as its oxide, in such approximate calculations, do not constitute a serious difference . . of Travancore monazite averages 8 to 9 per cent (compared to 4 to 5 per cent in Brazilian monazite) and 2 to 3 per cent "thorium" would therefore mean that the deposits should contain 25 to 30 per cent monazite, at least Such deposits are however unknown, as far as I am aware

Again, "Before World War II, monazite sand scooped from the sea shore on the west coast of India and from backwaters of rivers had been used in America to make paint for ships and for plastics."

The Mineral Companies which are engaged in concentrating beach minerals, certainly, do more than "scoop" up from the beach The mineral which yields "titania" which is used, in a variety of paints pigments and sizers is not 'monazite' but 'ilmenite'.

P. VISWANATHAN

Travancore Minerals Co, Ltd,
Quilon, S. India, 12-6-1946.

CARTHAMUS OXYCANTHA BIEB. (*KANTIARA*)—A NEW SOURCE OF FODDER

THE quantity of roughage available in India falls short of the requirement of the livestock population by about 45 per cent. The shortage is more acutely felt when there is partial or total failure of monsoon. Wars and famines have multiplied needs and created further shortages. With a view to meet these shortages, at least in par, the Animal Nutrition Research Section of Imperial Veterinary Research Institute, Izatnagar, U P have been making efforts to utilize so far unexploited fodder resources for animals In this note observations on the use of 'kantiara' as a livestock fodder are presented

Carthamus oxycantha Bieb (*kantiara, miankalai*—Punjab ; *kuzburai, khareza*—Trans-Indus) grows wild in the United Provinces, Punjab, Baluchistan, Afghanistan and westwards to the Caucasus during the hot months of May and June The spinosed clumps constitute an objectionable feature of grassy tracts.

The chemical analysis of *kantiara* indicated that the plant contains 11 03 per cent of crude protein, 1 3 per cent of calcium and 0 13 per cent of phosphorus Toxicological analysis gave no indication of the presence of any toxic component. In spite of its richness in crude protein and calcium, the animals do not go near it, on account of the spinosed leaves, even when no other grazing is available When, however, the spines of the dried plant are rounded off by beating with sticks, the animals show no disinclination and in a couple of days begin relishing it

Adult Kumauni bullocks were fed on dry *kantiara* and wheat bhusa in the proportion of 2 1, supplemented with cake These adult animals which ordinarily maintain their body weight, gained on an average about seven pounds in body weight during the observation period of eight weeks and presented a healthy appearance

In addition to the above, one group of animals was fed on dry *kantiara* and molasses for a period of fifteen weeks, a second on *kantiara* and oat hay for a period of ten weeks and a third group on green *kantiara* and wheat bhusa for a period of five weeks. In all cases the food intake was satisfactory and the animals maintained good health.

Result of a metabolism experiment on three bullocks fed on dry *kantiara* and wheat bhusa showed that the animals were in positive balance with regard to N, Ca and P. The digestibility coefficients of crude protein, either extract and nitrogen-free-extract were 57, 32 and 44 respectively. The digestible protein and starch equivalent per 100 lbs. of dry *kantiara* were 6·3 lbs. and 20·78 lbs. respectively

These observations place *kantiara* in the category of common cereal straws. The digestible protein is far superior to any of the straws while the starch equivalent values compare favourably with them.

It is suggested, therefore, that *kantiara* may be used with advantage as a supplement to the common straws in times of scarcity.

In the absence of any precise information as to the extent of its availability, it is not possible to define specifically the amount of extra food available from this source, but it is estimated that it would be considerable

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A METHOD OF DETERMINING THE SHRINKAGE FACTORS OF SOILS

THIS test is intended for obtaining data from which the subgrade soil constants like the shrinkage limit, the shrinkage ratio, etc may be calculated The *shrinkage* limit of a soil is that moisture content, expressed as a percentage of the weight of the even-dried soil, at which a reduction in moisture content will not cause a decrease in the volume of the soil mass, but at which an increase in moisture content will cause an increase in the volume of the soil mass. The *shrinkage ratio* of a soil is the ratio between a given volume change, expressed as a percentage of the dry volume, and the corresponding change in moisture content above the shrinkage limit, expressed as a percentage of the weight of the even-dried soil.

According to the standard of the American Society for Testing Materials[1] (Designation : D427-39) a sample of moist soil is given a particular shape in a special dish called the shrinkage dish. This is to find the volume of the dish. This moist sample is next even dried to a constant weight. The volume of this dried soil is determined by detaching and next forcing the soil cake into a special cup full of mercury with the help of a glass plate whose surface covers up the cup edges while the soil cake is kept immersed within the mercury by three elevated pins suitably fixed underneath the glass slap. Other necessary data

can be obtained for the calculation of the shrinkage limit and the shrinkage ratio

Now in this method one can not follow the actual course of volume changes resulting from successive decrease in moisture content of the soil Furthermore, the elimination of air bubbles from within the mercury cup whose open top is to be ultimately covered by the glass plate is generally not very easy, more particularly in the case of any irregular deformity arising out of the shrinkage operation at the bottom face of the dried soil block Again for taking out the soil mass after it has been dried to a constant weight one has to handle it very carefully so as not to allow any detachment of soil particles specially from the sharp edges of the prepared soil

The method suggested by Haines[2] is however, better so far as drawbacks mentioned above But for routine laboratory tests of soils, this method requires simplification The present method is an attempt towards this

A special test cage is made to hold the soil sample The soil sample to be tested is first of all given a cylindrical shape with a smooth surface at top and bottom by means of a special mould. The sample at this stage contains fairly high moisture content to assume this shape within the mould This prepared sample is dried at successive stages by placing it within the cage in a hot air oven and the corresponding moisture contents at each of these stages are obtained by weighing. The respective volumes of this soil cylinder are also conveniently obtained by dipping the cage with the sample within it in mercury in a tall and narrow glass cylinder to the same depth of the cage and observing the resulting free levels of the mercury The cage is so made that while dipping in mercury, no air bubble can be entrapped within this, the inner and outer surfaces are also so finished as not to allow any mercury to stick to these surfaces Again the soil sample being previously moulded to the particular shape possesses a smooth surface all round it and no mercury sticks on to its surface. The corresponding levels of mercury at different stages of the procedure are followed by means of a kathetometer. Measurements and suitable observations for determining the volume changes resulting from successive decrease in the moisture content are thus easily obtained. It has been found that in carrying out the routine laboratory tests with several samples, and more particularly during observations with one soil sample, the mercury undergoes no appreciable change. All that is required is to remove the very little scum that sometimes appear on the free surface This is the case after a number of samples have been experimented upon.

From such observations a graph is drawn as shown in the figure where the volume variations in percentage of the dry volume have been plotted against the corresponding changes in moisture content in percentage of dry weight The point at which this curve touches the abscissa showing changes

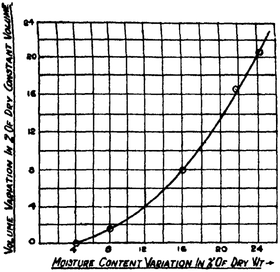

FIG 1 A specimen shrinkage curve for a sample of subgrade soil from the Maithon Dam site on the Barakar

in moisture content in per cent of dry sample weight determines the shrinkage limit. The shrinkage ratio is next obtained from the same curve by calculating the ratio as indicated by the two dotted lines The curve shows that at points much above the shrinkage limit, the sample loses volume proportionately to the moisture loss This evidently shows that results obtained by the present method are in full conformity with the actual shrinkage process within the soil mass as it loses its moisture

The details of the method and of the test equipments will be published elsewhere

My thanks are due to Dr N K Bose, M Sc, Ph D., F N I, Director, River Research Institute, Bengal for the kind facilities offered to me

K. C. Niyogi

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Bengal, 26-6-1946.

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INFLUENCE OF SOLVENTS ON THE ABSORPTION AND FLUORESCENCE SPECTRA OF SIMPLE AROMATIC HYDROCARBONS IN SOLUTION

THE spectral distribution of the absorption and the fluorescent bands of aromatic hydrocarbons is well known to be influenced by the nature of the solvents Some workers[1] in the field have attempted to correlate the shift with the dielectric constant of the solvent while others[2] have tried to connect it with its optical refractive index G Scheibe and W Fromel[3] in their discussion ascribed the effect to be due to dipole moment But the idea does not seem to have been generally accepted It appears more reasonable to assume that the field due to the molecular electric moment as well as the polarisation field due to the solvent molecules are responsible for the shift In order to examine whether the dipole moments alone are responsible for the shift we have studied the fluorescence and absorption of naphthacene in various solvents having no dipole moment while having different dielectric constants The absorption spectrum has been taken by the usual method and for obtaining the fluorescence spectra, the 3650, 4047 lines of the Hg arc have been used for excitation The results are given here.

The following data show conclusively that the absorption and the fluorescence bands of naphthacene

Solvent	Dielectric constant	Absorption bands in A	Fluorescence bands in A
Carbon tetrachloride	2 24	4750,4450,4200	4880,5200,5600
Benzene .	2 28	4790,4490,4250	4900,5250,5640
Carbon-disulphide .	2 58	4850,5430,4280	4930,5300,5700
Anthracene		4910,4600,4350	4980,5330,5740

are shifted towards longer and longer wavelengths regularly with increasing index of refraction and dielectric constant though none of the solvents have any molecular dipole moment The results show definitely that the polarisation field must be responsible for at least a considerable portion of the shift.

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Calcutta, 2-7-1946

[1] V Henri, *J de Physique*, *3*, 181, 1922
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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. SEPTEMBER, 1946 No. 3

THE ROYAL SOCIETY COMMONWEALTH (EMPIRE) SCIENTIFIC CONFERENCE

THE Royal Society Commonwealth (Empire) Scientific Conference was held at London, Cambridge and Oxford during June 17 to July 8, and was attended by a large number of distinguished scientists belonging to the United Kingdom, India, Canada, Australia South Africa, New Zealand and the colonies of the British Empire India was represented by a selected team of 14 scientists* The main conference was followed by a conference of official scientists (to which, however, non-officials were invited), which lasted from July 8 to July 22 The main resolutions adopted by the two conferences are given in the next article

What is the background of this great conference and what does India stand to gain by such a conference?

The last global war has demonstrated, as nothing else has done, what a tremendous potentiality science has got for achieving good as well as evil On the side of good is to be credited the tremendous improvement in the standard of living of the common man,—in food, health and living conditions, internal security, and escape from drudgery—in countries which have harnessed science to the good of their population This is reflected in the growth of the democratical spirit and in the raising of the average life from 29 just a hundred years ago to 62 in the U.S A On the side of the evil may be debited the lust for power with which it had intoxicated the great and small Powers of the world, the climax being reached in the Nazi Germany's attempt to impose its domination on the old world by sheer brute force That menace had happily been defeated, with the same weapons which were forged by the Nazis, but it has left in its wake a trail of misery and devastation, the like of which has scarcely been witnessed in the history of the world One has to visit the cities of Germany and Japan, which have been reduced to dust heaps by aerial bombardment and, in the case of the latter, by atom bombs, and witness the crowd of sullen, half-starved survivors who are leading a dog's life in these dust heaps of erstwhile great centres of human life like Warsaw, Berlin, Buda-Pest, Nagasaki, and Hiroshima and other German and alien cities One does not know how long it will take for the stricken world to recoup.

The pattern of world politics has also changed We are now left with only three great sovereign Powers The British Commonwealth of Nations, the United States of America, and the Union of Soviet Republics Many other countries still possess a paper sovereignty, but that is on sufferance and may be jeopardized at any moment by a fresh outbreak of world conflagration

Even the three surviving great Powers are not in a happy state of mind Political rivalry, scramble for the loots of the spoil and for the souls of the benumbed population of the conquered and client countries, and suspicion of any unrevealed weapon like the atom bomb which the erstwhile friend may not hesitate to use in case the differences lead to war, are keeping all of them mutually suspicious and dangerously alert Even the free exchange of scientific thoughts and information which, leading to

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* Professor H J Bhabha, Sir Shanti Swarup Bhatnagar, Sir Jnan Chandra Ghosh, Rai Bahadur Dr S L Hora, Khan Bahadur Mian Mohammed Afzal Husian, Professor K S Krishnan, Dr M S Krishnan, Professors P. C. Mahalanobis, J N Mukherjee, M. N Saha, Birbal Sahni, M. R Siddiqui, Colonel Sir S. S, Sokhey and Mr D. N. Wadia.

cross fertilization of scientific brains all over the world, is mainly responsible for the spectacular advancements in science within the last 30 years, is now subject to control by some kind of gestapo in every one of the victor countries

Of the three great Powers, the position of the United Kingdom and her dominions and colonies is in a sense unique The United States of America feels secure in her isolation, being separated from the old, war-worn world by two great oceans, in the power of her industries and organizations, and in the innate strength of her people who are not torn by any great difference in psychology Soviet Russia also feels strong in her limitless extent, in her inner resources which she is fast developing to the standard of U S A , and in the great unity which she has forged amongst her heterogeneous population by the abolition of capitalism, religion, and extension of the blessings of science to all her backward nationalities The British Commonwealth of countries has, on the other hand, a highly developed inner core in the islands of the United Kingdom, which has a population possessing the highest kind of training, political sagacity, industrial and scientific skill, and fine traditions But the islands themselves are extremely poor in natural resources, compared to U S A and U.S S R , and so long this great disadvantage has been met only by the free utilization of the natural resources of her huge empire According to the policy consistently followed since the Industrial Revolution of the nineteenth century, England has been the workshop and the English people the main carriers of merchandise all over the globe, while the dominions, dependencies and colonies have been mainly the suppliers of raw materials But this position has been resented and successfully challenged by the self-governing dominions of Canada, Australia, New Zealand and South Africa, and today, taking advantage of the two great wars, they have organized their industries and their utilization of natural resources on far more efficient basis, though there are certain factors which do not allow them to make the fullest use of their opportunities One of these factors, in fact the main one, is their small population in comparison to the great areas they command

Amongst the countries which have been so far governed by England, the worst case is represented by India. As we have pointed out again and again in these columns, India is potentially as rich as U S.A. or U.S.S.R , inspite of her smaller area, but her population has the poorest standard of living on the earth This is due to Tory England's consistent policy of treating India as only a store house of raw materials and a consumer of finished products

But the last two wars have clearly shown that this process cannot go on indefinitely and there must be a change of heart followed by a change of policy. If the group of countries included under the British Commonwealth of Nations is to enjoy an honourable existence between the two great giants of U.S A. and U.S S R , the natural resources of all the countries belonging to this group must be fully exploited, using the latest methods of science and technology. The ways and means of doing so is not so easy in such a loosely knit mass as the British Commonwealth countries, particularly when the different units are composed of such heterogeneous populations, with widely different psychologies, different outlooks in life, and different interests But there is also a common interest, *viz* , that of safety and security, which should outweigh the more trivial considerations

So long the starting of the great work of rehabilitation of India has been impeded by the persistent imperialistic policy of the Tory Party in the U K , but happily the Labour Government has broken away from those traditions and conceded to India the right of shaping her own destinies The biggest political party of India is now on its trial Happily, already before taking office, they have declared intentions regarding utilization of science and technology for the fullest development of the country in a manifesto issued sometimes ago, of which the following is the text —

(1) The Congress stands for equal rights and opportunities for every citizen of India

(2) It stands for the unity of all communities and religious groups and for tolerance and good-will between them

(3) It stands for full opportunities for people as a whole to grow and develop according to their own wishes and genius

(4) It stands for freedom of each group and territorial area to develop its own life and culture within the larger framework

(5) It stands for the re-grouping of provinces on a linguistic and cultural basis

(6) It stands for rights of all those suffering from social tyranny and injustice and for the removal for them of all barriers to equality

(7) The Congress envisages a free democratic state with fundamental rights and liberties of all its citizens guaranteed in its constitution.

(8) The Congress stands for a federal constitution with a great deal of autonomy for its constituent units

(9) The Congress will tackle the most urgent and vital problem of India, namely, the removal of the curse of poverty and raising of the standard of life of the masses

(10) *The Congress stands for modernization of industry and agriculture and social control of all sources of wealth, methods of production and distribution so that India may grow into a co-operative commonwealth.*

(11) In international affairs the Congress stands for the establishment of a federation of free nations, and

(12) The Congress will champion the cause of the freedom of all subject-nations and elimination of imperialism everywhere.

We may now invite the attention of the Provisional Interim Government, particularly of Pandit Jawaharlal Nehru, to the recommendations of the Royal Society Commonwealth Conference, for implementation and action. The team of Indian scientists which attended this conference had played its part in the evolution of these proposals. They are of an extremely general nature, and different units of the British Commonwealth of Nations will have to implement them, each in its own way.

It is desirable that the first National Government pays serious attention to these resolutions and forthwith mobilizes the scientific and technical talents of the country for national service.

RECOMMENDATIONS OF THE ROYAL SOCIETY EMPIRE SCIENTIFIC CONFERENCE

AT the Royal Society Empire Scientific Conference during June 17 to July 8, discussions took place on a number of topics Below we publish recommendations, reproduced from *Nature*, representing interpretations of the general views of delegates and guests which were framed by the steering groups for each of the discussions.

OUTSTANDING PROBLEMS IN AGRICULTURAL SCIENCE IN THE BRITISH EMPIRE

1 A Conference of soil surveyors and pedologists should be set up to consider the development of soil surveys in general and to co-ordinate methods of soil classification

2. Work is required on the structure of clays, of humus, and of the clay-humus complex, requiring advance of technique in studying finely divided material.

3 Work is required on the ion-water atmosphere surrounding colloidal bodies, including living organisms, root hair, and on the structure and binding force of the water This should include a study of reaction in interpenetrating atmospheres

(2) and (3) together should throw much light on the agricultural problems of soil structures, aggregation and stability to alternations of wetting and drying, anti-erosion properties, availability and fixation of plant nutrients and inhibition of uptake of one plant nutrient in the presence of another, for example, Ca K balance.

4. Further study is required in the subject of soil microbiology. This should include the relation of soil micro-organisms to soil organic matter, the availability of inorganic plant nutrients and plant pathology as well as such taxonomic work as may be necessary.

5. It is recommended that efforts should be made to evolve both methods and apparatus for studying the nature of the stress-strain relationships in soil in particular relation to cultivations.

6 Special study is required of the developmental and physiological action of the root in relation to its environment This involves the study of (*a*) the water relations, (*b*) the mineral relations of the root as well as root secretions and excretions

7 Physiological development of plants in relation to environment, especially temperature and light (intensity, duration and quality and therefore artificial and natural 'shade') should be studied

8. Investigations are required on the following problem (*a*) quantitative inheritance ; (*b*) incompatibility and sterility of wide crosses , (*c*) the induction of polyploids and the possibility of inducing desirable mutations , (*d*) breeding methods

9 Investigations are needed on the epidemiology of fungal, insect and virus organisms and on pathogenic species in relation to strain specialization

10. Further investigation should be made into methods of control of fungal, insect and virus attacks, especially the possibility of breeding for disease resistance and the nature of such resistance

11 Climatic surveys, both regional and local, are accepted as a pre-requisite to the investigation of agricultural problems There should be provided throughout the Commonwealth and Empire a series of meteorological stations measuring daily rainfall, free water surface evaporation, relative humidity, day and night temperature of the shaded and unshaded atmosphere and the quality and intensity of daylight

12 Both reconnaissance and detailed soil surveys should be available as a basis for ecological and physiological investigations of the field problems and concerning agriculture

13. Ecological studies of the natural vegetation should form part of regional surveys designed to afford an integrated pattern of climatic and soil relationships. For this reason, vegetational surveys need, whenever possible, to accompany soil surveys.

14. Animal physiology on a general basis and including all the chief domestic animals should be specifically studied. This is the need basic to re-

search on nearly all kinds of practical livestock problems, including those of pathology. The study (biochemical and microbiological) of ruminant digestion is a good example.

15 There is a dearth of men with ample knowledge of domestic animal physiology Steps should be taken to encourage their training and their subsequent employment

16. More knowledge is required of metabolism and enzyme systems of spermatozoa and of ova

All through the session there was insistence on the manifest dependence of agricultural science on further developments in the basic sciences

Physiological and Psychological Factors Affecting Human Life under Tropical Conditions and in Industry

General.—The Conference surveyed certain of the results obtained during the War in the laboratories of the Medical Research Council at Cambridge and London, and in the Department of Physiology University of Queensland It was agreed that much of this work had a general application to many countries of the Empire It was agreed further that facilities for developing this work, both in laboratories in the 'field' and in suitably equipped centres in the United Kingdom and Dominions, were desirable.

Special recommendations.—1. Physiological and psychological research carried out under artificial conditions for war-time purposes needs to be extended to actual conditions in the tropics and to industries in which high temperatures are encountered This would require the establishment at suitable centres (for example, in Africa and in the Far East) of well-equipped laboratories These should work in close contact with similar laboratories in the United Kingdom and Australia, in which the more basic research should be carried out

2 Research on output in industry in the tropics needs to be done as data are practically non-existent Investigation is required also into the habitability problems of clothing, housing and transport.

3. Attention is directed to the need for improvement of instruments for the study of climatic factors

4 An authoritative guide on standards for building (domestic and industrial) in the tropics on the lines of the reports of the Building Research Station of the Department of Scientific and Industrial Research is desirable

5. War-time standards of ventilating practice in the Services need to be reviewed in relation to civilian and industrial conditions in the tropics A revision of existing scales of warmth and comfort is urgently required.

6 There is a definite need for co-ordination within the Commonwealth. This should take the form of exchange both of workers and of information. It is suggested that a co-ordinating Empire Committee on Human Climatology should be set up. This would include workers in physiology, psychology, industrial hygiene, the related aspects of nutrition and also representatives from the allied field of tropical animal physiology

7 It is strongly recommended that provision be made for a number of research fellowships for Colonial medical graduates, to enable them to carry out research in climatological laboratories

8 The participation, by the Commonwealth countries concerned, in a co-operative study of air-conditioning and the consequent engineering developments, is recommended

Etiology and Control of Infectious and Transmissible Diseases

General—1 The Conference, having regard to the present state of knowledge of the ecology of infectious diseases, feels that there are grave dangers of spread from one part of the Empire to another and within certain Empire countries Particular attention was directed to malaria, yellow fever, schistosomiasis, trypanosomiasis, plague and cholera

2 More knowledge of the ecology of infectious diseases, their arthropod vectors, their reservoir hosts and the reasons for the persistence of infection in localized endemic areas is needed The attention of universities and other authorities should be invited to the need in many parts of the Empire for ecologists and entomologists, both medical and non-medical

Special recommendations—1 That an international organization should be established under the United Nations Organization to prevent the spread of diseases from endemic to non-endemic areas Such an organization would (*a*) control vaccination and inoculation in connection with diseases to which these or other such precautions may be held to be applicable, (*b*) ensure the freedom of aeroplanes, ships and other facilities for travel between different countries, from insects and other media of infection; (*c*) secure uniformity in regulations regarding certificates required by travellers between different countries, (*d*) devise such methods of administration as would avoid vexations and unnecessary impediments to the movement of travellers or goods

The Conference notes that existing regulations at airports and other transit centres are unsatisfactory owing to a shortage of trained sanitary inspectors and other medical personnel It would direct attention to the availability of a substantial pool of junior personnel suitable for recruitment into the required

sanitary service, among ex-Service men and women, particularly in India and the Colonies.

2. For the prevention of the spread of certain diseases from endemic to non-endemic areas within particular countries, the Conference urges that local and permanent organizations are required for containing and controlling with diseases in the endemic areas Particular reference is made to cholera and plague.

The Science of Nutrition with Particular Reference to the Special Problems of the Empire, including the Nutritional Status of the Indigenous Peoples of the Colonies

Preamble—The Conference recognizes that the improvement of the nutritional status of the peoples of the Commonwealth is a part of general social and economic policy in the territories concerned. It urges the necessity for developing at all levels of Colonial government a proper awareness of the nutritional needs of the indigenous peoples

The Conference strongly supports the need for integrating the efforts of producer, consumer, technical and administrative personnel in effecting improvements in nutrition In this connection the suggestion put forward at the first session of the Conference of the Food and Agriculture Organization for the achievement of such integration is welcomed

The Conference agreed upon the evidence of malnutrition in the Empire, both as to quantity and quality, and urges that measures should be applied immediately for the improvement of the present position

Special recommendations—1 Immediate therapy of vitamin-deficiency diseases, particularly vitamin B_1 for beriberi in Malaya and Hong Kong, iodine in goitrous areas in Nigeria, calcium and vitamin D in areas where rickets occurs in the Gold Coast, iron where anaemia is common, especially in British Guiana.

2. The introduction into the diet of indigenous peoples of nutritional supplements, such as iodine, calcium, iron.

3. Improved methods of storing, processing and distributing foodstuffs, such as better methods of milling wheat and maize, the parboiling of rice, the drying of fish, fruit and vegetables The Conference urges the need for more food technologists in this connection.

4 Increased production of the 'protective foods' through · (*a*) the control of livestock diseases ; improved animal husbandry and animal breeding, especially of local strains, with the object both of increasing the productivity of the native pastoralist's herds and of developing dairy types suited for use in native mixed farming areas, (*b*) increased and improved fishing operations with the following general objectives (*i*) fishery exploration and fish catching (fishery engineering), (*ii*) fish processing and technology, (*iii*) fishery biology and hydrography, (*iv*) development of great lake fisheries together with fish culture in fresh and brackish waters.

5. Increased food production generally by. (*a*) the greater use of fertilizers ; (*b*) the extension of plant breeding More plant surveys and an increase in the number of trained plant breeders are urgently required for this purpose, particularly in the African Continent

Modern Methods of Mapping and Exploration by Air

The Conference agreed that the use of radar would much reduce the time required for the making of maps In view of the importance of completing the topographical mapping of various parts of the Commonwealth for the purpose of economic development, the Conference put forward the following recommendations

1. Research and development in radar and photographic equipment and techniques in air survey should be vigorously pursued, if the full scientific and economic advantages of these methods are to be obtained in all parts of the Commonwealth

2. The appropriate authorities should be approached with the view of increasing the number of persons trained to conduct further research in these subjects

Scientific Information Services

General—The Conference invites the Royal Society at an early date to convene a conference of the libraries, societies and institutions responsible for abstracting and information services, in order to examine the possibility of improvement in existing methods of collection indexing and distribution of scientific literature, and for the extension of existing abstracting services. The Conference would pay particular regard to the cost of such services and to the need for funds from Government sources for their support

In the proposed conference (1) Representatives of the appropriate authorities in the Dominions, India and the Colonies should be included, together with observers from the United States (2) The interests of scientific men as users of scientific information

should be especially considered. (3) Consideration should be given to the abstracting of Dominion journals locally, for transmission to the main abstracting bodies in the United Kingdom.

Special recommendations.—1. Consideration should be given to the establishment of a network of information services throughout the Dominions. Such a network would provide central focal points and for a two-way transmission of matter (either direct or through existing local centres adapted for the purpose)

2. In view of the need of the scientific worker for possession of individual scientific papers on his own subject, the possibility of the publication, classification and distribution of papers in separate form or as reprints should be considered

3 The issue of occasional reviews of special branches of science both for the specialist and for the general scientific reader, is considered desirable as a supplement to other forms of publication

4. The extended provision of micro-film and other forms of documentary reproduction is considered important for the rapid transfer of information throughout the Commonwealth. An economic service for the purpose requires centres in the United Kingdom and in each of the Dominions

5. The Conference recognizes that the qualifications of staff in scientific information services and special libraries call for special training and selection, and recommends the provision of facilities for increasing the number of properly trained staff

Interchange of Scientific Workers Throughout the Empire, and the Future of War-time Scientific Liaison Offices

The Conference agrees that interchange of scientific staffs, both of universities and research institutions, is of vital importance to the maintenance and development of scientific research within the Commonwealth and Empire

1 To promote such interchange the Conference strongly urges upon all the responsible authorities the urgent need for. (*i*) adequate provision by universities and research institutions to enable the senior and junior scientific staffs to take periodical leave for overseas visits, both short—and long-term; (*ii*) the raising of staff complements to a level sufficient to afford individuals adequate time for research and for study or for special leave without thereby placing additional burdens on their colleagues, (*iii*) provision of the largest practicable number of travelling scholarships for post-graduate work (see also 2 (*ii*) below); (*iv*) a system of adequate financial provision for travelling and subsistence allowances to avoid loss to the individual due to differences in living costs in different countries; this is to apply both for members of university staffs and for holders of travelling scholarships; (*v*) the provision of resources to enable the invitation of scientific workers from overseas for short periods to advise or for collaboration in specific research projects, (*vi*) the exemption of all travelling scholarships and allowances from income tax either in the country of origin or of reception.

2. To the same ends the Conference further recommends. (*i*) an official policy for continuance and development of a system of Commonwealth liaison offices as being an essential part of the machinery for facilitating interchange of scientific workers and activities connected therewith, and directs that the attention of the Official Conference be invited to the matter; (*ii*) urges the need for the central compilation and publication of a list of scholarship facilities existing within the Commonwealth and proposes that the task be entrusted to whatever organization may be employed for centralizing scientific information services; (*iii*) invites the attention of the Official Conference to the need for the adoption of a uniform superannuation scheme for the Commonwealth to facilitate transfers without prejudice to such rights, (*iv*) notes with anxiety the serious handicap to interchange caused by the high cost of sea and air transport, and invites the Royal Society to initiate action with the appropriate organizations to remedy the position

Empire Co-operation in the Scientific Field with Existing and Projected International Organizations

1 The Conference recommends that the delegations should advise their Governments to adhere to each of the international scientific unions, to the International Council of Scientific Unions and to other recognized international scientific organizations.

2 The Conference recommends that scientific correspondents be appointed in Colonial territories to establish and maintain direct contact in scientific matters with the operational agencies of the United Nations and with other recognized international bodies.

3 The Conference would heartily welcome a policy on the part of the United Nations and its operating agencies to make the utmost use of all scientific bodies which are doing valuable work of an international scientific character and would stress the importance of preserving the independence of such bodies and of leaving the control of their activities to scientific men.

4. The Conference recommends that each delegation should advise its Government and the established scientific institutions of its country to collaborate closely with any organization of the United Nations concerned with the promotion of science and its applications

Standards of Measurement

1 (a) It is considered highly desirable that early steps should be taken to eliminate the slight difference in the values of the yard and pound at present in use in the Commonwealth and in the United States of America

(b) It is recommended that discussions should be pursued with the appropriate authorities in the United States with the view of reaching mutual agreement on this question (as a basis of recommendations to Commonwealth authorities) and that the Director of the National Physical Laboratory, Teddington, should act in this matter on behalf of National Laboratories in the Commonwealth

The Conference suggests that (i) the reformed units should be precisely related to the corresponding metric units, (ii) tentative values for conversion factors should be as follows 1 yard = 0 9144 metre exactly, or 1 inch = 25 4 mm, 1 lb = 0 453 592 37 kgm or 0 453 592 3 kgm

2. The Conference advocates the adoption of the metric system in all fields of science Examples of subjects in which an improvement in this respect is desirable are aeronautics and pharmaceutical science

3 If text-books and scientific data or memoirs are expressed in systems other than the metric, conversion factors or the metric equivalent should be included

4. The Dominions and India should participate in the organization of the Convention du Metre

5. There should be meetings at suitable intervals of representatives of the Commonwealth National Laboratories to consider (a) the maintenance of uniformity of standards of measurements, (b) general programmes of research in regard to fundamental scientific standards The National Physical Laboratory in Great Britain should act as the co-ordinating body. The Conference emphasized the importance of mobility of workers between the various laboratories.

6 Within the Commonwealth there should be organized a service of radio transmissions at standard frequencies which, together with those of the United States, would suffice to meet the needs of the Empire

7. The United Nations Standards Organization be asked to give consideration to the question of nomenclature and symbols at the international level, taking into account, so far as is practicable, both scientific and industrial usages

8. The Conference records its appreciation of the advances which have been made in the international standardization of biological materials and noted with satisfaction that much of this standardization is now brought on to a physical and chemical basis.

Collection of Scientific Records and Material and Risks Involved in the Distribution of Plants, Seeds and Animals

1. Having regard to the limitations of space and scientific man-power, we recommend a policy of rationalization in respect to research collections for taxonomy To this end the avowed scope and objective should be publicly stated by each institution, especially as to the particular groups for which it accepts responsibility of intensive representation

2. When new species are described, replicates should, where possible, be provided for major cosmopolitan collections and for those institutions where the group concerned is intensively studied. For unique specimens, microfilms, casts, etc, should be similarly provided

3 Increased provision be made for the training of taxonomists and that an increased number of taxonomic posts be created

4. Better facilities be provided for the collection of living material, for its reception when collected, and its subsequent maintenance

5 To ensure early action and continuing attention for varietal collections of economic species, for genetic and breeding purposes, one organization in the Commonwealth should be specifically entrusted with the essential central co-ordination

6. Adequate quarantine measures should be taken respecting new introductions to ensure their supervision before release and competent diagnosticians be available Such quarantine measures to be supplemented by a good intelligence service.

7. Information regarding the geographical distribution of pests and diseases should be made readily available

8 Steps should be taken to preserve native breeds of livestock

Land Utilization and Conservation throughout the Empire

In view of the gravity of the situation caused by the loss of and damage to the soil in many parts

of the Commonwealth, the Conference attaches great importance to the carrying out of the following recommendations, with the help of trained agricultural scientists (a) erosion surveys, (b) soil surveys, (c) investigations relating to the maintenance and improvement of soil fertility

In addition to the above investigations, the Conference urges the importance of surveys to determine the present pattern of and trends in land use, as a basis for the maintenance of soil fertility

In view of the similarity existing between problems of soil conservation in different parts of the Commonwealth, the Conference would emphasize the importance of a continuous interchange of information and the need for periodic conferences of specialist officers engaged upon problems of soil fertility, erosion and land utilization

A Co-ordinated Survey of the Mineral Resources of the Commonwealth

General.—The Conference reviewed carefully the position regarding the mineral resources of the Commonwealth in relation to the serious present and threatened further shortage of many important key minerals, and agreed that a much increased Empire effort is required in all aspects of geology, geophysics, mineralogy, process metallurgy and in the compilation of reliable data on which estimates of present and future supplies of minerals may be made

Special recommendations —1 That a Commonwealth organization be established with headquarters in Great Britain to include the following functions, some of which are performed already by the Imperial Institute (a) To act as a clearing house for information, statistical and general, on the scientific and economic aspects of the mineral resources and mineral production metallurgical industries of the Empire (b) To institute, in concord with the various Governments of the Commonwealth, standard methods of recording figures of production, trade and resources in mineral and metallurgical products (c) To promote the exchange of information regarding the estimation of mineral reserves and/or to publish estimates at suitable intervals (d) To provide an information service dealing with publications concerning all branches of geology, mineralogy, palaeontology, geochemistry, applied geophysics, oredressing and production metallurgy (e) To refer to suitable specialist institutions for advice or investigation, mineral problems and specimens, for the study of which facilities may not be available at the time in most parts of the United Kingdom, Dominions, or Colonies; and to advise on the extension of existing, or establishment of new, institutions as may from time to time be considered necessary to meet the requirements in these respects of the Commonwealth.

2. That systematic geological survey work being the foundation of all progress in the mineral industries, in future much stronger geological organizations are essential for work in all parts of the Commonwealth

3 That attention be given to proposals to assist established British journals of geology, mineralogy and palaeontology, etc.

The Conference reviewed with approval the accompanying summary of the essential functions of a geological survey and agreed that anything short of this programme would generally prove to be an uneconomical investment of public funds.

Appendix Essential Functions of a Geological Survey

Official geological surveys should be maintained in sufficient strength to permit of

(a) The development of the general geological map, which will become the guide for all prospecting activities, official and private, as well as for operations regarding water supply and engineering projects

(b) The preparation of a geological map by stratigraphical geologists is not possible without the constant reference of questions to specialists in palaeontology, petrology, mineralogy and geophysics

(c) For the development of the mineral resources of a country to the best advantage, it is important for a geological survey department to be familiar with the statistics of production, imports and exports From the figures of such returns the department can advise its Government to direct its policy to the encouragement of industries based on raw mineral supplies, for it is oviously uneconomical to export raw minerals which might be smelted or otherwise processed near their sources, and equally uneconomical to import materials and articles which might be manufactured from minerals of domestic origin

(d) It is essential to build up at the headquarters of a survey a reference library and a collection of reference specimens It is equally important to maintain publications in recognized form, through the distribution of which geological officers will get the criticism as well as the appreciation of outside scientific and technical communities

(e) The activities of a geological survey department should be purely advisory; but as the full list of specialists and equipment required is generally beyond the capacity of smaller States and Colonies

to maintain, it is desirable to federate for such advisory functions suitable groups geographically and politically related to one another

Natural Products of the Empire and the Chemical Industries that are or might be Based on them

In view of the varied nature of the natural products of the Commonwealth, their wide geographical dispersal and the diverse and often inadequate facilities in staff and equipment which may be available locally for their investigation, the Conference makes the following recommendations

1 That a standing central committee, including representatives of the United Kingdom, the Dominions, India and the Colonies, should be set up to advise upon policy for the co-ordination of research, both scientific and economic, into the natural products of the Commonwealth Such advice upon their own particular problems would be made available to all Commonwealth countries with the minimum of delay.

2. The Conference, while recognizing the desirability of centralizing research upon problems common to many parts of the Commonwealth, supports very strongly the view that research upon problems of more local interest should be co-ordinated within regions. It is anticipated that this would lead to increased efficiency and economy in man-power The Conference regards advice upon the concentration or regionalization of the research in question is an important function of the central committee

Post-War Needs in Fundamental Research

The Conference wishes to direct the attention of all concerned with the guidance of fundamental scientific research to the Royal Society's "Report on the Needs of Research in Fundamental Science after the War" It would also invite attention to the report on scientific man-power recently issued by the Government of the United Kingdom. The discussion at the Conference, which was of necessity limited in scope, revealed a particular shortage in the Commonwealth of scientific workers in such fields as taxonomy, genetics and microbiology.

1. The Conference is of the opinion that in each country of the Commonwealth the mechanism for guiding long-term research in fundamental science should be reviewed, in order to foster fertile research work in all important subjects The systems for advice and financial assistance in this connection should be studied carefully.

2. The needs of the future will require a great increase in the number of scientific workers, and it is considered important that plans for extending fundamental research in any field should be supported by measures designed to increase the number of trained scientific men able to carry out such plans

3. In order to secure the proper flow of young scientific workers from educational establishments, it is considered of importance that the educational system of each country should be harnessed so far as may be necessary to this particular long-term need

Africa as a Regional Area for Fundamental Scientific Research

1. The Conference considers that there is a growing need for the development of long-term fundamental research dealing with African problems on a regional, as distinct from a territorial, basis

2 To meet this need there should be formed at an early date a Commonwealth African Research Committee with the following terms of reference (*a*) to examine and put forward proposals for the centralization of fundamental research in African problems on a regional basis, (*b*) to plan such developments ahead so as to ensure the necessary financial support and the training of the specialist staffs needed, (*c*) to advise the Governments concerned through the appropriate authorities on matters of regional development and co-operation in fundamental research.

3 The field of the Committee would in the main cover activities south of the Sahara, and foreign States with territories in this portion of Africa should be invited to be represented as observers.

Cosmic Rays

The Conference recommends that the following investigations of cosmic radiation would be of great scientific value and are also likely to have important meteorological applications

1. Further measurements of the variation with time of the cosmic ray intensity at selected stations at sea-level and on mountains Measurements in the southern hemisphere are of particular importance

2. Further measurements of the variation of cosmic ray intensity with latitude and longitude by experiments in aircraft over a wide range of height

The Conference recommends that the necessary organization to carry out the work should be set up in the first instance on an Empire basis, but that the question of extending the organization be raised at the next meeting of the International Union of Physics.

The Village Pond in the Rural Economy of India

The oceanographic and fisheries scientists present as delegates to the Royal Society Empire Scientific Conference request its Steering Committee to arrange that if possible a meeting be called during the period of the British Commonwealth Scientific Conference of these delegates, and other specialists available in Great Britain, to discuss methods for co-operation and co-ordination of fisheries and oceanographical research within the Commonwealth, and similar matters of common interest

The above delegates also would appreciate any facilities which could be given for a tour to centres of fisheries research in the United Kingdom following the termination of the Official Conference

(Action on the above recommendation was taken immediately)

Geochemistry

Delegates attending this discussion endorse the recommendation contained in the Royal Society's Report on the needs of research in fundamental science after the War "that substantial provision should be made for quantitative spectrographic analysis of rocks, minerals and natural waters"; and further, recommend that adequate facilities in one or more institutions should be provided for like investigations (both fundamental and applied) on material which might be submitted from centres (including Colonial geological surveys and other geological organizations) within the British Empire

Hormones

In view of the steady increase in the demand for insulin, the Conference urges that a strong recommendation be made to all the countries of the Commonwealth that every effort be made to collect, process and preserve all available pancreas. Purified insulin, which can be stored for long periods without loss of potency, will be needed on an increasing scale for the treatment of diabetes.

Fish Culture and Malaria Control

In view of the great possibilities of utilizing ponds for fish culture in various countries of the Commonwealth where malaria is prevalent, the Conference proposes that the attention of governments of countries so situated should be directed to the urgent need of integrating fish culture practice with measures for malaria control

THE HOW OF INDUSTRIALIZATION

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The Conventional Method—A Wrong Approach

IN industrializing a backward country at the present day, one must shed many preconceived and outmoded ideas that have become like catch words in the popular mind The sign posts as national planning, basicity of industries, established processes, buying the know-how, expert advice, technological training, etc., on the highway of industrialization, lead the traveller more often astray than to his destination There is nothing inherently wrong with these markers but their meaning is read out of context with concurrent advanced technology Even the technologists of a backward country only understand the language of technology but not its idiom. As in the story of a Japanese interpreter, the proverb "out of sight, out of mind," became when retranslated into literal English, "unseen is insane," so these slogans give rise only to confusion.

Methods of industrialization that were adequate in the horse and buggy days are entirely unsuited in an age of automobiles, radio, radar, aeroplanes and atomic energy The conventional method of purchasing a plant for an established process and securing the help of foreign engineers and experts for design, construction and operation of the plant appears to be wrong if the newly constructed industries are to survive competition The first law of true industrialization is that the production costs of an industry must be materially lower than the selling price of the imported article The second law states that the soil must be permeable to allow the deep penetration of the roots so that the new industry may gain strength and become sturdy The third law demands that good heritage be provided so that no congenital defects or weaknesses appear in the industry.

The reason why the conventional method seems wrong is that it wantonly breaks the laws of industrialization. Industrialization is not merely an assemblage of factories with smoke stacks and creaking machines where something comes out from the assembly line as a product It is really a culture where the various processes as intellectual seeds are housed, financed, powered and fed with raw materials As in agriculture, the seed, the soil and care-taking are of prime importance in the production of crops, so in the production of industrial articles, process, suitable plant and technology are of importance These together with raw material and labour account for the manufacturing cost. It is evident that India will have to pay high for the importation of process, plant and technology and that she possesses no advantage in raw materials and labour Hence the production costs of any manufactured article are expected to be higher than the corresponding imported material Of course, in spite of all this, certain manufactures would be profitable if there were counterbalancing factors of cheaper transport or specialized market, etc Normally, however, only such industries will survive competition as possess or develop an over-all economic advantage in manufacture

This is borne out in many industrial ventures that were undertaken in India since 1920, such as Tata Oil Mills Company at Ernaculum, Bhadravati Iron Works in Mysore, Shri Shakti Alkali Works of Dhrangadhra, Dharamsi Chemical Works near Bombay and Tata Chemicals, Ltd , of Mithapur It may be argued that many of these have survived and even made considerable money Lest the intent here be misunderstood, I will define my terms When I speak of survival from competition I mean in normal times and not survival due to tariff, subsidy or emergency conditions of war. It is reasonably sure that the production costs of these companies are too high to make it possible to survive foreign competition in normal times It is true that planning and engineering have been defective in some of these, but it is contended that even under ideal conditions they will be unable to survive.

Let us analyze the most favourable example of an industry under what might be called ideal conditions. Unlike the sulphuric acid industry, the soda industry can neither claim the lack of raw materials nor lack of an adequate market. The analysis of this industry under ideal conditions will, it is believed, show why an industry organized under the conventional method of buying a plant for an established process has little chance of survival. The soda industry requires ample resources of salt, limestone and coal. All these resources are ample but do not occur in all localities and hence suitable locations will be relatively few from the standpoint of raw materials and the nearness of the market Thus if soda industry were to be located in northern India where coal, salt and limestone are plentifully available, the transport of the product to textile centres of Ahmedabad, Bombay and Sholapur would be prohibitive If, on the other hand, the industry is located near Ahmedabad or Bombay, as it now happens to be, the cost of both limestone and coal becomes too high for production economy Let us forget these considerations for the time being and see what the production costs would be without considering location of raw materials, transport or engineering

The so-called economic unit of such a plant is of 100 tons daily capacity and a plant of such a capacity for ammonia-soda process can be bought in the U.S A for about 25 lakhs of rupees The cost of production of soda in the U S A. is about Rs 35 per ton on the basis of Rs 3 per dollar. On the basis of salt at Rs 5 a ton, limestone at Rs 6 a ton and ammonia loss of 20 lbs per ton, coal at Rs 10 and coke at Rs 20, the plant cost including design, erection, etc , at 80 lakhs, depreciation and interest at 12 per cent, administration based on importing 3 people on Rs. 5,000 a month, labour approximately half as much as in the U S A and maintenance at twice the figure, the cost per ton of soda itemized comes as follows :—

Raw materials	$ 6 70
Fuel & power	9 00
Administration & labour	4 00
Depreciation, interest & insurance, etc	10 70
Repair & maintenance	1 40
Total	$ 31 80 or Rs 95 4 per ton.

It is doubtful whether this figure can be realized in practice as even a slight error in planning requires additional expense by way of consultation, additional appliances, etc.

Any one who is familiar with the record of Dhrangadhra Alkali Works and Tata Chemicals Ltd of Mithapur will realize that this cost picture is quite a conservative one Now, to survive from foreign competition, it is evident that the production costs should not be much higher than those of the competing country. In such an event, the advantage will be in favour of India and will be equivalent to the cost of transport and the import duty If the import duty is fifteen per cent *ad valorem*, the advantage will amount to about 55 per cent over the manufacturing price of a foreign competitor. It is here assumed that the profit margin and sales promotional expense etc. remain the same for both.

At any rate, the production costs of an Indian industry should never be more than fifty per cent higher than those of its foreign competitor if it is to survive economically Now the production costs of the Indian soda industry even under ideal conditions are two hundred and fifty per cent higher as shown above No doubt some economies are possible when, for example, the services of the foreign technologists are terminated and so on But they will not be so large and significant as to reduce the percentage by two hundred and bring it within the range where survival is possible. If the most favourably conditioned industry has no chance of survival, others which are congenitally defective or wrongly planned could not be expected to fare any better It is therefore contended that industrial development of India will be fraught with failure if the conventional method is followed in construction

POWER ENGINEERING AT THE INDIAN INSTITUTE OF SCIENCE

(Contributed)

IT is now a recognized fact that electrical development is a *sine qua non* in the industrial progress of a country. Even those who put all their eggs in the one basket of cottage industry concede that electricity can take the edge off the drudgery associated with many cottage industries There is, in fact, a consensus of opinion that electrical development must be given the highest priority in the economic regeneration of India.

The development of the electricity supply industry will naturally form the principal programme in the first stage of development The construction of new hydel and thermal power stations and transmission lines as well as the acceleration of the existing schemes of construction will fill up the bill in course of, say, first five years The lack of manufacturing facilities in India will preclude the possibility of their fabrication in this country and these perforce must be purchased from abroad. What will be urgently required in the initial stage is technical personnel, particularly for superior positions, who can formulate schemes for the generation of electric power, instal complicated machinery, and supervise over their smooth operation The vast number of post-war power development schemes makes the urgency all the more acute.

The graduates in engineering in India when they emerge from their college course do not possess sufficient practical knowledge and experience in Power Engineering for any responsibility being immediately entrusted to them. It is common knowledge that adequate facilities do not exist in this country Proposals have, therefore, emanated for the establishment of a post-graduate Power Engineering Department for imparting specialized training in Power Engineering to selected civil, electrical, and mechanical engineering graduates, for producing adequately qualified engineers for power development and operation mainly for the electric supply industry and also for large industrial undertakings having their own generation plants.

The Indian Institute of Science has done pioneering work in the realm of technical education in India. It was the first Institute in India to have a course in Electrical Engineering of the University standard. It was, therefore, expected that the Institute would take a lead in the development of Power Engineering for which there is a crying need in India To meet this need, an Expert Committee, under the Chairmanship of Prof. M N. Saha, F R S, was formed in September, 1944, for drawing up a comprehensive scheme for training in the Institute superior personnel in Electrical Engineering The Committee which consisted of eminent electrical engineers engaged in the electrical supply industry and in technical institutions as well as several outstanding scientists of India have recently published their unanimous recommendations.

The Committee is unanimously of opinion that a post-graduate course of two years' duration in Power Engineering should be established in the Institute The object of the course is to provide instruction for engineering graduates from Indian universities in Power Engineering (Hydro, Thermal, and Electrical) for a period of two years so that the students specializing in the course might be able to take up immediately and discharge with confidence superior responsibilities.

The Committee proposes the admission of 60 students every year to the course.

(1) 15 civil engineers, specializing in civil works and hydro-electric installations.

(2) 15 mechanical or thermal engineers, specializing in thermal power and hydro- electric installations.

(3) 30 electric engineers, specializing in electric power generation, transmission, and utilization.

The Committee further advocates the introduction of a short intensive refresher course for a limited number of engineers already engaged in the electrical supply industry

As to the syllabus, the Committee recommends that the students specializing in any one of the three branches will receive ancillary training in relevant portions of certain subjects common to all the three branches, which are considered essential for the proper all-round training of power engineering, where the subjects appear common with undergraduate courses in Indian universities. It is intended that the training be of a higher order and not of the type imparted to these students in the course. ment will form common subjects to all the three sections of engineers The Committee also suggests the inclusion of extensive course of lectures by acknowledged experts in the various branches of power engineering industry.

The unique feature of the scheme is the provision of a well-equipped thermal power station consisting of two 500 KW turbo-alternators and all ancillary equipment This the students will operate under controlled conditions under the supervision of the teaching staff This will not only acquaint the students with every feature of a modern power station but will also greatly help them in gaining confidence in operation

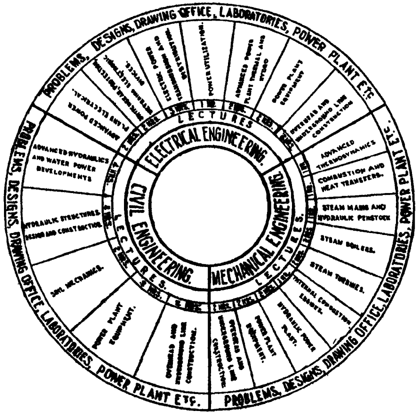


FIG 1.

A SUGGESTED 2 YEARS POST-GRADUATE COURSE IN POWER ENGINEERING CIVIL, MECHANICAL, (THERMAL) & ELECTRICAL CURRICULUM FOR FIRST YEAR

The details of the curricula for the three branches are reproduced graphically in Figures 1 and 2 reproduced from the original memorandum. It will be seen that such subjects as Power Plant Equipment, Overhead and Underground Line Construction, Power Plant Design Costing, Layout and Testing, Co-ordinated Projects, and Power Supply Economics and Manage-

The Committee rightly stresses the importance of practical experience to power engineers. Not only has a provision for an intensive course of practical training for the recruits in the well equipped thermal power station, hydraulic, mechanical, electrical, high voltage and research laboratories and workshops been made, but particular emphasis has been laid on six months' practical experience in the electric supply

industry on the completion of their course at the Institute.

The Committee wisely emphasizes the importance of practical experience in the selection of staff It rightly insists that the staff must have thorough experience in electric power generation, transmission, and utilization and that practical experience must be given priority over teaching experience In view of the importance of the selection of personnel on the success of the scheme, we hope that the best available men irrespective of their nationality, caste, or creed will be selected.

The vastness of the scheme can be judged from the fact that it will entail a capital expenditure of 60 lakhs of rupees and a yearly running expense of over 4 lakhs of rupees The Department will employ five professors, 8 assistant professors and a number of lecturers, technical assistants etc.

There is a strong current of opinion among many eminent members of the Institution of Electrical Engineers, who take an active interest in technical education, that the students must put in one year in a factory before they can be considered eligible for admission in an engineering course. We suggest that one year's practical experience in the Electrical Power Industry be regarded a prerequisite to the admission of engineering graduates to this course. The graduates will come with an appreciation of the technical difficulties they encountered during their practical training. This will enhance the usefulness of the present course.

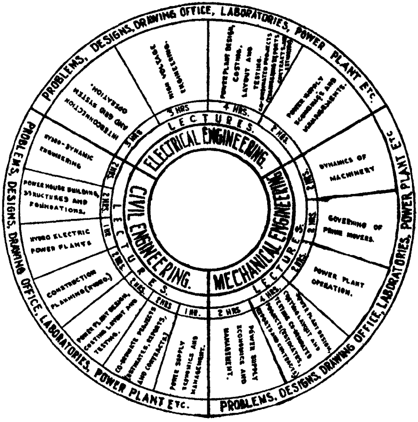


FIG. 2.
A SUGGESTED 2 YEARS POST-GRADUATE COURSE IN POWER ENGINEERING CIVIL, MECHANICAL, (THERMAL) & ELECTRICAL CURRICULUM FOR SECOND YEAR.

Also it is natural to expect that the manufacture of electrical machinery will develop in the wake of the expansion of the electric supply industry as otherwise the latter will cause a colossal drainage of much-needed capital from India The manufacture of electrical machinery is, in reality, a part and parcel of Power Engineering development scheme. As most of the subjects for this are already included in the curriculum for electrical and mechanical engineers, the accommodation of this course of specialized training in the designing of machinery and its construction with a view to advancing the electrical machinery manufacturing industry in India, in the

Power Engineering Department, will entail but little additional expense and will immensely contribute to its usefulness. We also hope that the utilization of electrical energy, especially on the large scale basis, will be given more attention in the course We suggest these modifications in a spirit of constructive criticism of the project.

Boldness and vision—two cardinal qualities indispensable for the reconstruction of any phase of national life in any backward country—characterize the authorship of the scheme The care and thoroughness with which the details have been worked out redound to the credit of the recognized experts of the Committee The establishment of the Power Engineering Department in the Indian Institute of Science will go a long way in the fulfilment of the cherished wishes of its great founder, Jamsetji Tata, for the upliftment of technical education in India.

We trust that the Government of India and Indian industrialists will not stint in their financial support for the early implementation of this worthy scheme.

REORGANIZATION OF SCIENCE TEACHING

RANG BAHADUR MATHUR

If science is to succeed in the building up of our nation, it should be taught well in our schools The whole edifice of future India, healthy, wealthy, and prosperous, of scientific advancement, scientific research, of science applied to industry, of science in the service of man, rests on the problem of the proper teaching of this subject

I would like the Government, the scientists, the educationists, teachers of science, and all those interested in the education of the people to pay serious attention to this problem in its narrower sphere of formal instruction in class. As the impress of science on the various activities and spheres of life, economic, social and political, is growing, and its influence on human thought deepening, it is essential for us to analyze our ideas and clarify our thoughts about it The best result in my opinion will be obtained, if a Committee is set up, of selected scientists and educationists, to survey the whole field of science teaching in India, to study the present conditions, trends and needs, and on the basis of these to give advice and suggestions according to which science teaching be reorganized in the country in the future

Though good science teaching is essential right through in schools, colleges and universities, it badly needs a thorough overhauling at the school stage, to bring it in line with the needs of the times It is only in schools that a good foundation of an all round elementary scientific knowledge can be laid, on which later on the structure of higher scientific training can be based. But to me the claim of those who will not pursue the study of science beyond the school stage for better teaching of the subject seems to be more insistent. For all what they will learn of science will be in schools and this they will require to understand better the world they live in, and to enable them to make use of it everyday to improve their homes and daily lives Hence I plead the cause of better teaching of science in schools.

General Aims of Education

As science needs a complete overhauling and reorganization in schools, it may be well to tackle this problem from the very beginning The first question to answer is Why do we teach science? What are the important general and the more specific aims or objects for doing it? What is it we actually want the students to learn or achieve by the study of science?

In the first instance the general aim of teaching science is the same as, in fact it supplements and contributes to, the general aim of school education I would enunciate the aim thus —To foster in the rising generation such attributes as physical fitness (health), worthy home membership, democratic citizenship, wise choice of and efficiency in work, social service, and integrity of character

This statement of aims is based on the aims put forward in the report of Dr Zakir Hussain Committee, p. 12, and the Report by the Central Advisory Board of Education on Post-War Educational Development in India, p 28 To these I have added worthy home membership In India great efforts are being made to foster in the people the ideas of unity and patriotism, the love of the masses, and the love of the country But nothing is being done to encourage and intensify in their hearts, the love of their homes. If the people are not made to love their homes, they will never be able to love their homeland. The home is the centre, the core, of all forms of social, economic,

or governmental organizations. Unless the idea of work or social service as a citizen for a community is linked up with an individual's home the idea of democracy will not catch with the people The ideal of a good and worthy home life will give a concrete and objective shape to the present abstract and vague ideas of unity, patriotism and democracy.

Objectives of Science Teaching

Besides the general aim we should consider the scientific objectives or particular reasons for teaching science and its special claim as a separate subject to be included in the school curriculum These are —

1. The acquisition of scientific knowledge and the understanding of the basic scientific laws and principles, which are necessary to the citizen of today, to enable him to solve the problems of his life involving science and pertaining to health, home, vocation etc.
2. The development of the skill in scientific thinking—a scientific attitude of mind This helps to change a man from careless to a careful thinker
3. The establishment of certain attitudes and ideals as a respect for and confidence in the scientific method, a feeling of admiration for the self-sacrificing devotion to the service of society by great scientists, a feeling of reverence for the universe we live in, and a realization of the lawfulness of nature
4. The development of wholesome scientific interests which will lead to a desirable use of leisure time and may form a basis for educational and vocational guidance

The essential and relevant questions to consider in connection with this problem are —

1. What should we teach? What subject matter is best calculated to accomplish our aims? What should be its extent and in what manner should it be organized in order to be effective?
2. What methods of teaching should be adopted in order to accomplish the results sought? How can the students be made to learn science most effectively?

Basic Principles of Science

Any education should enable a student to effectively adjust himself to the various factors of his complex environment. This he will be able to do, if he has the ability and skill to meet the problematic situations of his life, whenever they arise, successfully. If science is to help him in this, he must be given an understanding of certain basic and important principles and laws, which are needed in solving the common problems of everyday life. He must also be given much practice to develop skill, in the use of these principles, to solve his particular problems

An analysis of this question shows that:—

(1) A student needs to learn principles and laws of science, not scientific facts,

(2) Certain basic and important principles, common to all, have to be mastered by all the students;

(3) These principles are of general science, not of any particular branch of it,

(4) Types of problems met in daily life have to be found out,

(5) Practice is to be given in solving these problems with the help of the principles learnt.

The implications of building up a course of studies involving the above points mean simply that it must be built round the needs, interests, and abilities of those studying science,—an important tenet of progressive education and well worth remembering by curriculum makers, authors, and teachers of science The course should be comprehensive and complete in itself, should deal with general science, and be composed of only essential and basic principles.

That the high school science should be general in character is now recognized by all authorities on education and science teaching

In the admirable Report on 'Post-War Educational Development in India' by Sargent, it is stated "High School education should on no account be considered simply as a preliminary to University education, but as a stage complete in itself Also that a large majority of high school leavers should receive an education that will fit them for direct entry into occupations and professions" I hope it is indicative of the changed outlook on education in India It also bears out the plea that the high school science course should be comprehensive, complete in itself and general.

According to the new scheme, the high school consists of three and not two classes It will be all the better if general science could be given in all of them. Otherwise it may be had in the first two years followed by Physics, Chemistry, Biology etc. as separate subjects only in the last or 11th class.

Regarding the essential and basic principles of science we will have to carry out a search for them. We will have to analyze human activities, children's interests, need of the times, as well as the judgment of other men regarding the value of certain principles

and topics. The types of problems met in the daily life of an average person must similarly be found out

In America sometimes back such a list was made by analyzing the contents of standard text-books, daily papers, magazines, journals etc Professor Downing gives such a list in 'An Introduction to the Teaching of Science', Pp 30-36. It is not complete but illustrative of the methods employed, and the results obtained in this connection

Such principles are, for instance —

The Law of conservation of Energy —Energy can be neither created nor destroyed , it can be changed from one form to another with exact equivalence

A body at rest or in motion tends to remain at rest or to continue in motion in a straight line until some force acts upon it

The cell is the structural and physiological unit in all organisms

If and when we are able to ascertain such a list, it will be possible to write new text books which will give mastery in principles to the students and ability of applying them in their daily lives Such a course, even if not very extensive will serve as the best preparation for life, and a dependable foundation on which the college or University work may later be based.

Scientific Thinking

That the development of a scientific attitude of mind is one of the most important aims of science teaching is claimed by almost all the scientists and educationists How necessary it is to develop this in our own students need not be stressed. If at all, it seems more essential today than even the acquisition of scientific knowledge If India is to aspire for democracy and education is to be the instrument of achieving it, science teaching should more and more help in training the students to acquire the skill in scientific thinking

But this training in scientific thinking is a tricky thing. It does not come by itself by just studying science as it is taught at present in our schools It can only be given if the aim of doing it is kept constantly in view. It is the result of the technique employed in giving an understanding of the scientific principles, and the ability of employing them in real life situations.

Science has never been looked in this light in our country so far. The teachers have not been conscious of this aim. With the reorganization of science teaching, they will have to bear it constantly in mind, and keep it in the focus of their attention, to give practice in scientific thinking to the students, intelligently and persistently.

If the following steps are regularly taken in the study of science, by the teacher or the student dealing with problems placed before him, and if models of such procedure from the works of great scientists are presented to them, the desired result are bound to be obtained

1. Observations made should be purposeful.

2. Observations made should be accurate, extensive, and made under a variety of conditions

Data or facts so obtained should be collected and arranged

3 An analysis and synthesis should be made and the essential point in the problem picked out Both similarities and dissimilarities should be considered—exceptions to the general rule carefully considered.

4 Experiences relevant to the problem should be recalled in order to make selection of the underlying laws or principles A wide range of experience is necessary for this.

5 Hypothesis should then be made but all possible ones must be considered and tried one after the other.

6. Formulation of the law or principle.

7 The inference made should then be tested experimentally

8 The right judgment should then be passed, but it should be unprejudiced, impersonal and suspended

Emotion and Attitudes

It is commonly believed that science essentially trains an average person to become practical and materialistic. The rapid rise of industrialization and commercialization lend support to this view It is felt science trains the hands and heads of the people but leaves out the third member of the trinity, the heart, neglected, untrained and unaffected Along with right thought, and right action, should go right feeling. A good command of the important principles of science and a skill in scientific thinking should be accompanied by noble desires which should motivate both thinking and action. If science provides the tools of materialistic progress, it should also direct their use Unless it does so, there will be all the difference between science in the service of man and science for the destruction of man.

It is one of the important objects of education to ennoble the emotional feelings in a man like ambitions, desires, ideals, tastes and attitudes of mind. Though

"as an instrument of education, science cannot replace what are traditionally called the humane studies", according to Westaway, it can help students to acquire certain ambitions, ideals, wants and feelings that fall quite naturally within the domain of science.

For instance, in trying to know and study nature, we come to enjoy it, love it, and have sympathy with it—which amounts to an insight into nature

The fundamental impressions created on the mind of man by Nature are —

(i) A sense of world power—that Nature is dynamic

(ii) A feeling of the immensities—the great magnitude of the Universe

(iii) Feeling of the universal flux-rythmic circulation of matter

To these may be added the impressions of (iv) beauty, (v) manifoldness, (vi) intricate complexity of the web of life, (vii) evolution and (viii) lawfulness of nature

From a study of the history of science we get a feeling of admiration for the self sacrificing nature of the great scientists, working away for the welfare of humanity, rather than exploit their fellow men We also get a respect for science, when we see how science has developed slowly and what it has cost in time, human effort and sacrifice. We come to have too, a respect for and confidence in the technique of science, that in solving a problem, the way of science is better and preferable to other ways

How can these desires and attitudes of mind be taught to the students? These are not taught, but caught by the students from their teachers The teacher must possess these emotions in overpowering form in order to impart them to others He must be full of anecdotes from the lives of great scientists, and the poetry of nature, to spread the emotional contagion in his students He should also suggest readings in the history and biography of science, and such other books like 'Discovery' by Gregory and 'Microbe Hunters' by Panl de Kruif, to his students, wherein they can come directly in contact with men who possess and can effectively impart to them such ideals, desires and fine enthusiasms

"We seek contact" writes Professor Downing, "with those ennobling emotions in the hope that some of them will lay hold of us, control us, inspire us, lift us out of our base selves and having melted down by their fervent heat the elements of what would otherwise be a drab and commonplace life, pour us into a purposeful, heroic mold"

Selection of Subject-Matter

Dr Sargent has rightly stated in his report that in education the teacher is the crux of the whole matter But as the system is at present constituted the teacher does not seem to be in the picture at all Take the case of science The syllabus is laid down for him, the sequence of the topics decided, the names of the experiments given, and the text book he must teach the students already prescribed The inspectors of schools almost force him to adopt one or the other method of teaching and the aids to teaching he must employ The examinations are conducted by outside bodies, and his work judged by the results he can obtain Besides, there are other restrictive forces working within the school itself Not infrequently, many a headmaster, an old graduate of arts, and neglectful of the claims of science, tries to play the role of a mean, little tyrant of the petty domain of the high school, and assume, like the famous French King, "I am the School" It is impossible in this atmosphere for any good teaching to ensue Perhaps this state of affairs will go on till there emerges on the scene some Rousseau, some philosopher of the future Indian educational revolution Gandhi and Sargent if they choose to, can effectively play this part For unless the present oppressive atmosphere of the schools clears up, it seems futile to talk about reconstruction, or reorganization of teaching procedures

The syllabuses or courses of study at present laid down for the high school are in separate subjects like physics, chemistry, biology, physiology, and hygiene They are formulated by subject matter specialists, the professors of different subjects from the colleges

They are aimless, or in other words, they do not take into account the general or the specific aims of teaching science, or of the special subjects They are just a logical listing of topics in different subjects and entirely dominated by text books They are uncorrelated *i e*, do not take into considerations the phenomena that will be studied in different subjects nor are in any way linked up with what the student has studied before, or, will study later They do not pay any regard to the psychological characteristics of the learner, his needs, interests and understanding They do not form any foundation or standard of scientific knowledge for the students There are many topics that have to be taken up in the college afresh after they have been dealt with according to the course in the high school Sometimes the topics are so listed that they do not give a connected and coherent idea of the subject to the students at all In their present privileged position, the professors domineer over school education by writing text books and becoming examiners, while the cause of education suffers. I think the first step to be taken in the cause of better teaching of science or of any subject will be to remove this stranglehold by college professors on high school education

This should not be difficult now High School education, is to be complete in itself, and the teachers will be all trained M. A's or M Sc's They are more qualified to lay down the syllabus, prescribe the text-books, and conduct the examinations than the college professors who are all untrained M A's or M Sc's If they are Ph.D's or D Sc's they are still less qualified, for being too highly specialized in one subject, for the high school They may be consulted for curriculum making, but they should not dictate it

In future the high school science curriculum should be made by one single committee representing the whole field of science, operating under a supervisor The members should normally be all school masters, the supervisor being a person of wider outlook, and greater experience, if possible a specialist in science teaching or in curriculum making The committee should formulate a general view point, lay down general principles about science teaching, and selection of subject matter It should try to form a syllabus of general science, by co-ordinating the teaching of special science courses and bringing them in line with the educational aim

There are four important principles or criteria for the selection of subject matter to consider in laying down a curriculum, according to Beauchamp, and the committees should pay heed to them

1. Does the subject matter appeal to the interests of boys and girls as worthwhile and real in their daily lives?
2. Is it possible to organize the subject matter in such form that the method of study gives proper training in desirable attitudes, habits, skills, and ideals?
3. Is the subject matter such that the knowledge gained has a real, positive value in the life of the pupil?
4. Are the subject matter and the method employed of the proper degree of difficulty so that the pupil can thoroughly understand the subject matter through serious study?

These may still be sub-divided, but the point to be stressed here is that the syllabus should be built round the needs, interests and abilities of students, as has been mentioned already

These principles can also be of great help to the teacher in modifying and reorganizing current syllabuses and text, to suit the interests and needs of his students.

Organization of Subject Matter

The next important question after subject matter has been decided upon, is to consider how it should be organized. What are the methods according to which it can be done?

The first and most obvious one is to list the different topics under different headings and branches of science, for instance —properties of matter, mechanics, heat, light, sound, magnetism and electricity under physics Similarly with chemistry, biology, geology and astronomy A G Hughes writes in Elementary General Science, (A Book for Teachers), "Many senior school courses are arranged on some such basis, the syllabus in each branch being set out in a separate column and the whole called general science Some reformers have apparently felt uneasy about the columnar type of syllabus, and though they discuss science in its conventional water-tight compartments, they recommend teachers to lose no opportunity of making cross-references from one subject to another This is no more than a helpful palliative The most it can do is to mitigate some of the harm done by what, in our opinion, is a fundamentally wrong approach to the subject, it may, for example prevent some pieces of knowledge from remaining isolated in children's minds when they ought to be related But so far from saving time, it probably consumes time, for not only have we to teach the separate courses, we must also teach how one course is here and there connected with another There is no hope of solving the problem of science in senior schools until, resolutely turning our backs on branches of science and the columnar type of syllabus, we adopt a totally different method of approach The chief reform needed in science teaching today is the replacing of 'patch work' methods of teaching by a 'one piece' method "

The unit method of organization may well be called the 'one piece' method A learning 'unit' according to Professor H. C Morrison, who lent the idea to this form of organization of subject matter, is defined as a "comprehensive and significant aspect of the environment, of an organized science, of an art or of conduct, which being learnt results in an adaptation in personality" The problem of organization in general science is "a search for the comprehensive and significant aspects of the environment in the field being studied—comprehensive in that each aspect explains a great deal, and significant in that it is important and essential"

According to this system the science course is organized in units or 'learning allotments'. Each unit deals with a worthwhile important problem or activity from the daily life of the student, which calls for study, investigation and experiment in the fields of physical and natural sciences. It does not entirely forsake the logical organization of the present day curricula, but the logical organization is subordinated to the natural or psychological organization based on

activities and needs. A unit signifies relationship between group of facts, phenomena, or applications, and the few principles of science underlying them These are carefully developed through a study of the environmental science. An adequate number of such units, ample in scope, and interrelated will give a pupil a synthetic view of science

For instance according to the organizations of science in units, we will have such units for study —

1. What is the atmosphere and how does it affect our daily lives?
2. How are our homes provided with an adequate water supply?
3. How did the Earth come to be as it is today?
4. Of what use are animals to man?
5. How can one keep his body healthy?
6. How have machines made the work of man easier?

Compare to this the listing of the topics in present day courses.

PHYSICS :—

1 Measurement of space and time
2 Mass, Weight, and Density
3 Parallel forces Centre of Gravity Machines
4 Effects of Heat Thermometry etc,

CHEMISTRY —

5 Burning and Rusting
6 Chief gases of the Air.
7 Water.
8. Phosphorus Matches etc,

A unit is divided into smaller parts or concepts A series of problems are raised, through the solution of which the student arrives at the required idea or concept

For instance the unit "what is the atmosphere and how does it affect our daily lives?" can be divided into three parts. (*i*) Do we live at the bottom of a great ocean of air? (*ii*) How are atmospheric pressure and compressed air used to do work? (*iii*) What is the atmosphere made of? The problems raised in part (*i*), are —Where can air be found? Does air have weight and exert pressure? How does man use the air for travel? The problems raised in part (*ii*) can be —What gases make up the atmosphere? Which gas in the air is necessary in oxidation and combustion?

Each of the problems call for experiments, study etc , on the part of the students These are of the type that are real to life, and are associated with the needs and interests of the students In working these out, and in arriving at the scientific principles involved, the student has to make use of those mental processes which lead to a training in scientific thinking Here also he had to deal with the facts of science, but they are means of arriving at or verifying the principle The emphasis in this case is on generalization arrived at by a student after thinking a problem out, and not just memorization of facts Moreover while a unit can be definitely organized to impart the right ideals and attitudes, only occasional smattering of history and biography of science can be given otherwise, which proves inadequate for our purpose These are the great differences between the two methods and they show the superiority of the unit method of organization over the present day topical organization

(To be concluded)

Notes and News

OBITUARY: BIRAJ MOHAN DAS GUPTA (1887-1946)

By the death of Rai B. M Das Gupta Bahadur, on the 25th May last in Calcutta, India has lost an outstanding medical research worker

Born at Baherak, Vikrampur (Dacca), Mr Das Gupta had his early education at Ichhapura High School, Vikrampur and St Xavier's College, Calcutta and later licentiated in medicine from the Medical School, Dibrugarh (Assam), winning several prizes and medals.

In 1910, he was employed as a Sub-Assistant Surgeon under the Assam Government and held charge of mufassil dispensaries During the World War I (1914—18), he served the Army Medical Service in the Brigade Laboratory at Bannu, North-West Frontier Province (India) His fine technique and careful microscopic work brought him to the notice of Col. Mackie and later of Capt Knowles

On reversion to civil duty in 1918, he joined the Pasteur Institute, Shillong as a colleague of Capt Knowles and the latter joined the School of Tropical Medicine, Calcutta as Professor of Protozoology in 1921 In recognition of his work, Mr Das Gupta was transferred as Assistant Professor of Protozoology Soon after Das Gupta was promoted to the rank of Civil Assistant Surgeon in Bengal Medical Service (Upper)

On the death of Lt Col Knowles in 1936 Mr Das Gupta succeeded him as Professor and later in 1943, he was the first Bengalee to be appointed as Director, School of Tropical Medicine, Calcutta

Prof Das Gupta's work in the domain of medical protozoology brought him international fame In 1934-35, he visited Baltimore (U S A) with the Rockfeller Foundation Fellowship and he also visited England, France, Germany, Italy etc. and came in contact with the leading protozoologists of the world

Prof. Das Gupta contributed a large number of papers on various aspects of medical protozoology, malariology and allied subjects in various journals of India, Europe and America.

Das Gupta (with Knowles and White) published in 1930, a memoir on the malarial parasites (*Ind Med. Res. Mem.*, 18) and later (1932) his work on the parasitology of monkey malaria and its experimental transmission to man and on the latent malaria infection in monkeys have clarified many important points (*Ind. Med. Gaz.*, *67 & 69*) He also studied the various protozoan parasites of lizards, birds and on those affecting the health of domesticated animals.

Das Gupta further investigated on the diagnosis of Kala-azar, on the leptospiral jaundice in Assam, on the Weils' disease and the rat-bite fever in India Earlier in 1929, some puzzles and fallacies in the examination of stained films in the tropics were elucidated by him in collaboration with Knowles and Acton

In recognition of his research work in Tropical Medicine, he was awarded the Minto Medal and later made a Rai Bahadur in 1944 Prof Das Gupta is the author of the second edition (revised and abridged) of the book entitled 'Knowles's Introduction to Medical Protozoology' (1944) and contributed a chapter on "Rat-bite fever" to 'British Encyclopaedia of Medical Practice'

At the time of his retirement in April 1946, he was invited to a post at the London School of Tropical Medicine but failing health prevented him from accepting that honour

Prof Das Gupta was for sometime nominated a Fellow, State Medical Faculty, Bengal, President, Indian Medical Association (Jhargram Branch); and on several occasions acted as a member, Board of Examiners to adjudicate upon theses submitted for the degree of Doctor of Science of several Indian Universities

FREE EDUCATION PLAN

A PLAN to make literate 55,000,000 children and young persons and 250,000,000 adults by a free elementary education of six to eight years' duration and for conscripting qualified persons as teachers to carry out the plan has been finally approved by the priority sub-committee dealing with education of the National Planning Committee

The plan lays stress on the following items that are to be put into operation immediately

(1) A required elementary education period for children of six to eight years' duration

(2) An adult literacy programme for both sexes both for those past the schooling age and those remaining illiterate because of wastage or stagnation in their school period.

(3) Free nursery or kindergarten classes for children under school age at the expense of employees, local governing bodies and voluntary associations.

(4) Conscription of qualified persons as teachers and special provision for training one *lakh* of teachers annually, along with increase in salaries as well as other facilities and amenities

(5) The use of radio and motion pictures as part of the educational programme, especially for adult illiterates

The proportion of the illiterate adult population in India is, according to the report, roughly 85 per cent of the total. Only 10 per cent of the population can at all be classed as literate. Of the latter, men outnumber women by five to one For the training of these will require the services of at least a million persons each giving full time attendance for one year.

This programme, of basic education—free, compulsory and universal is estimated at not less than Rs 200 crores annually, could be financed over a period of 10 years or more, and chiefly paid for by the funding of private agricultural debt through the State at a lower interest rate

We hope, now that that the interim Government is in office, their plans for education and food (see *Science and Culture*, June, 1946) would be the first items to be taken up for national reconstruction of India

UNITED NATIONS FOOD AND AGRICULTURAL ORGANIZATION

THE establishment of a 'World Food Board' with funds and authority to ensure enough food for all, equitable distribution of food to every country, prevention of famine and slump, sponsored by Sir John Boyd Orr, Director-General, F A.O , was agreed in principle by delegates at the conference, held recently at Copenhagen The objects of the Food Board will be to

(1) stabilize prices of agricultural goods in world markets,

(2) establish a world food reserve adequate to meet any emergency caused by crop failure anywhere,

(3) provide funds to finance disposal of surplus agricultural products to countries urgently needing them, and

(4) co-operate with organizations concerned with international and agricultural development and with trade and commodity policy

The conference further considered the establishment of a minimum world food target of 2,600 calories per person daily According to a world food survey of 70 nations conducted by F.A O., it is observed that about half of the world's population was seriously undernourished in pre-war years, subsisting at a level of food consumption not high enough to maintain normal health, allow for normal growth of children, or furnish enough energy for normal work

In most of these countries, a substantial increase in the consumption of fats, peas, beans, fruit, vegetable, milk, meat, fish and egg is required Assuming an increase of 25 per cent in world population by 1960, it is estimated large increase in the production of various food crops is required e g , cereals 21 per cent, sugar 12 per cent, milk 190 per cent, meat 46 per cent, and fruits and vegetables 163 per cent

The plan provides means for encouraging the modernization of farming methods in all agriculturally backward countries and promoting greater industrialization for eliminating poverty which is the chief cause of malnutrition

India has direct interest in the F A O , as it will be the endeavour of F.A O to raise the level of nutrition and standards of living of the Indian people, to improve the efficiency of agricultural production and distribution and to better the conditions of the rural population of India

Addressing the conference, Sir J P Srivastava (leader of the Indian Delegation) said—"India is still desparately short of cereals particularly rice, manures, agricultural machinery and technical man power The aim of the new Government of India will be not only to remove the threat of famine but also increase the prosperity of the cultivators, raise the level of consumption, provide balanced diets and create a healthy and vigorous population India has to increase its cereal resources amounting to 6,000,000 tons a year and of other foodstuffs aggregating nearly 90,000,000 tons in the shortest possible time "

Dr R K Mukherjee, one of the members of the Indian Delegation and Chairman of the Committee on Economics and Statistics said—"Open spaces of earth are mostly in tropical and sub-tropical belts where a planned policy of reclamation, drainage and agricultural colonization undertaken through international loans could contribute to remove the world food shortage "

The Indian Delegation to this conference included Sir J. P Srivastava (leader), Dr Baini Prashad, Khan Abdul Ghani Khan, M L A , Dr R K Mukerjee, Prof. N. G Ranga, Dr V K R V Rao, Dr G Sankaran, Dr D. R Sethi and Mr W Christie (secretary).

Dr Kaufmann, the Danish Minister in Washington was elected Chairman and Sir J. P Srivastava as one of the Vice-chairman of the Conference

Eire, Portugal, Italy and Switzerland were admitted as members of the F A.O., thus bringing the total number of membership to eight

The F.A.O. will meet in Washington on November 1 next to prepare plans for the world food board.

CORN INDUSTRY IN U. S. A.

THE production of hybrid seed corn has now become an important industry in U.S.A This is the result of the investigations by George Harrison Shull, Professor Emeritus of Botany and Genetics, Princeton University, who in 1905 commenced his studies on variation in maize as affected by inbreeding In 1909, Shull communicated his 'Pure-line method of corn breeding' to the American Breeders' Association in Columbia (Missouri) and the last experimental crop grown by him was in 1916 Three decades have elapsed, for a general understanding of the importance of this fundamental discovery and full realization of its benefits

Shull had invented a method of procedure that assure greater yields and greater uniformity, sharper specialization to fit different regions, different climates, different soil, and the production of strains having desired chemical content or any other qualities The fact that the relation between deterioration due to inbreeding and the increased vigour due to cross-breeding are two aspects of the same phenomenon was also recognized for the first time

The success of this endeavour has been due to at least a dozen great commercial companies, which are now producing the major part of the many millions of bushels of hybridized seed corn required by American farmers every year

The Hi-Bred Corn Company, established by Henry A Wallace and the work of the other commercial corn hybridizers have led to the success of this new industry Wallace's company now grosses more than $1,000,000 annually and several still larger companies are approaching a $10,000,000 annual turnover The production and sale of hybrid seed corn has now become an industry with an annual turnover of about $75,000,000

A conservative estimate of the increase in national corn production during the years 1942-45, due to the partial use of hybrid corn is 1,800,000,000 bushels The money value of this increase is more than $2,000,000,000 It is, therefore, no exaggeration to say, speaking in terms of the over-all national economy that the dividend on our research investment in hybrid corn, during the war years alone, was enough to pay the money cost of the development of the atomic bomb (*Science*, May 3, 1946)

THE TANNER

THE advent of *The Tanner*, a monthly exclusively devoted to the tanning industry and allied trade fills a long-felt want as we had no journal exclusively devoted to the tanning industry in India It is edited by S Raja, well-known to the profession, and published by him at Jer Mansion, Bandra, Bombay 20. We are in receipt of the first three numbers of this new monthly published in June, July and August, 1946 and it is a welcome addition to the list of professional journals in India, that emphasizes mainly the trade aspects of the industry

It has been calculated that in India there are about 200 million heads of cattle and 93 million of sheep and goats and she is one of the largest producers of raw hides (of bullocks, cows, buffaloes, horses, camels, etc) and skins (of calves, sheep, goats, deer and other wild animals) in the world and thus possesses an unique opportunity for the scientific advancement of her tanning industry. The industry has now developed to a highly specialized scientific industry and is one of the major industries of great economic importance to the country and is capable of annual production worth about Rs 130 crores

By this new medium it will be possible to ventilate the views of the industry, to present its problems with a view to their solution and to disseminate technical knowledge and commercial information We wish the new journal every success.

MINERAL INFORMATION BUREAU

A MINERAL information bureau under the supervision of Mr D N Wadia, F N I and assisted by the staff of the Geological Survey of India is to be set up shortly in Calcutta under the Department of Works, Mines and Power, Government of India

The main functions of the Bureau will be the dissemination in non-technical language of facts and correct information relating to Indian minerals, fuels, iron ore and ferro-alloy minerals, light and base metal minerals, precious metals, gems, minerals for chemical industries, industrial clays, sands and miscellaneous minerals

The Bureau will further advise on the use and processing of raw minerals and quantitative data on the availability and suitability of minerals for industries and will help industrialists by carrying out laboratory tests and by recommending technologists for mine survey, geological survey, prospecting and opening up of economic deposits

The services of the Bureau will be free, though small charges may be levied for special analytical work A quarterly journal—*Indian Minerals*—will also be published under the editorship of Mr Wadia which will contain articles written mainly in non-technical language on matters relating to the different aspects of mineral development in India and short accounts of such developments in other parts of the world.

It may be recalled that the idea of an "Economic Minerals Bureau" was sponsored for the first time

in India by the Geological, Mining and Metallurgical Society of India (See *Science and Culture*, *10*, p 427 & *11*, p. 300)

ANNOUNCEMENTS

Accepting an invitation from His Excellency the Viceroy to form an *Interim Government*, Pandit Jawaharlal Nehru, General President, Indian Science Congress Association and Chairman, National Planning Committee, has formed the new Government in India, of which Pandit Nehru is the Vice-President

The *Interim Government* took charge with effect from 2nd September last and Pandit Nehru has taken over the portfolios of External Affairs and Commonwealth relations

Prof P C Mahalanobis, F N I, F R S, Honorary Secretary, Indian Statistical Institute, and General Secretary; Indian Science Congress Association, has been invited by the Dominion Statistician, to advice the Canadian Government about the sampling organization recently set up at Ottawa He has also accepted the invitation to attend a special conference arranged by the Population Association of America in New York in October In America he will also address a number of universities

Dr U N Chatterji, D Phil, D Sc(Alld), F.N A Sc, has been appointed Editor of Publications, Imperial Council of Agricultural Research, New Delhi

Dr Chatterji carried out a planned programme of original investigations on various problems connected with the metabolism of plant as a Post-Graduate Research Fellow and later as a lecturer in Botany in the Allahabad University His work has been highly appreciated in India and in foreign countries and has been quoted or otherwise referred to in standard books in Plant Physiology. (See *Science and Culture*, 11, p. 366).

Dr Chatterji also served for sometime as a Special Officer in the National Academy of Sciences of India He joined the editorial staff of the I C.A.R in April, 1945 and has impressed by his abilities So far he happens to be the only person with distinctive scientific training to be appointed to the Editor's post in the I C A R.

Rai Dr S L Hora Bahadur, D Sc., F R S E, F L S, F Z.S, F.N I, Director of Fisheries, Bengal, has been elected an honorary foreign member of the American Society of Ichthyologists and Herpetologists at the society's annual meeting held recently at Pittsburg.

ERRATA

On page 35, of the July, 1946 issue in line 46 (column 2) *read* Rs 15,000 *for* Rs 1,50,000, and on page 43, line 25 (column 2) *read* Dr K. P. Basu *for* Dr U P Basu.

SCIENCE IN INDUSTRY

SUGAR SYNTHESIZED

DRS W Z HASSID, M Doudoroff and H A Barker, of the University of California, have recently succeeded in synthesizing cane sugar from simple sugars (*Science News Letter*, June 29, 1946) In this attempt, they have further synthesized two new sugars not known to occur in nature

Cane sugar is a double molecule, built up of two simpler sugar molecules With the help of an enzyme obtained from a culture of the bacterium *Pseudomonas saccharophila*, the scientists at California were able to combine glucose phosphate with fruit sugar to make cane sugar The phosphorus compound which is responsible for the formation of the double molecule acts as a catalyst and is not otherwise involved in the reactions The important part played by the phosphate group is a new discovery, and it is stated that the failure of many earlier attempts to link up the simpler sugar molecules was clearly due to lack of appreciation of the essential role of phosphate compound in bringing about such complex molecular grouping

Two new sugars, yet unknown in nature, have been further synthesized by following, more or less, the above procedure Glucose phosphate was made to combine with sorbose in one case and with ketoxylose in the other Glucosido-sorboside, resulting from the former, resembles the double sugars of the maltose, lactose, and cellobiose type Sorbose, the unusual constituent of the new sugar closely resembles glucose, the difference lying in certain groupings of atoms The ketoxylose of the second new sugar is similar in structure to the fructose half of the cane sugar molecule Both are ketoses, whose structure is fundamentally different from that of glucose, although both contain equal numbers of carbon, hydrogen and oxygen atoms.

Appreciation of the process underlying the synthesis of simple sugar molecule to the complex molecules of the double sugars now opens the possibility of studying the behaviour of the two halves of the sugar molecule in the body and their transformation to blood sugar Such studies, if carried out successfully, will lead to a fuller understanding of the part played by sugars in nutrition and body chemistry, and also of the process involved in production of carbohydrates by the growing plant Application of tracer experiments, using radio-active phosphorus isotope, in future research work of this type has been strongly suggested.

BLOCKING-LAYER PHOTO-CELLS

THE *Philips Technical Review*, March, 1946, opens with an article by W Ch. Van Geel entitled 'Blocking-layer Photocells" These are instruments which convert light into electrical energy In principle they consist of a semi-conductor (*e g*, copper oxide or selenium) and a metal, separated from each other by a very thin layer of insulating substance (blocking layer) Such a combination when illuminated exhibits the so-called blocking-layer photo effect The light causes electrons to move from the semi-conductor through the blocking-layer to the contiguous metal, from which they may then return to the semi-conductor through an external resistance Without any further mear being employed, a photo-current of measurable size is immediately obtained, which has of course very much promoted the application of blocking-layer photocells, for instance, in photographic exposure meters, lux-meters, photometers and colorimeters The article discusses the structure of blocking-layer photocells, the current and voltage generated therein and the mechanism of the electron mover in the cell.

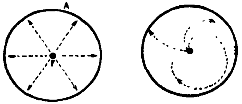
THE CAVITY MAGNETRON

THE difficulty of developing a powerful generator of microwaves long remained a formidable problem in the progress of radar, both as a weapon of defence as well as of offence. The solution of this problem has come largely through the development of a magnetic device of generating microwaves, known as cavity magnetron. Weighing only a few pounds and capable of producing waves of about only 9 cms in length, the magnetron has enabled aircraft to be provided with radar equipment for safer navigation and for manifold purposes of offence and defence

Conventional types of oscillator valve for centimetre waves would have to be of almost microscopic dimensions Even if they could be made at all, the maximum output would be quite inadequate The method of controlling the flow of electrons by means of an electric field, applied by a grid placed in the stream, becomes almost impracticable at such wavelengths A magnetic field is used instead, in quite a different way

Figure 1 (*a*) is an end view of a very simple type of valve, in which F is a straight filament, surrounded by a cylindrical anode A to which a high positive voltage is applied This anode draws to itself the

electrons emitted from the filament, along radial paths as shown A simple diode valve such as this can be used as a rectifier and not much else But if a magnetic field is applied, acting parallel to the filament, the electrons find themselves forced into curved paths, as indicated in Fig 1 (b) As a result, they land on very different spots on the anode from those towards which they originally started, or may even miss the anode entirely and spiral back to the filament By dividing the anode into two or more segments, inter-connected by resonant circuits, a suitable combination of anode voltage, magnetic field strength and valve radius results in continuous oscillations being generated



(a) Fig 1 (b)

End view of simple consual 2-electrode valve The dotted lines indicate typical electron paths from filament to anode (a) Without magnetic field, and (b) with magnetic field parallel to axis

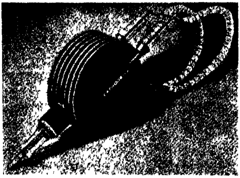


Fig 2.
A Cavity Magnetron for 9-10 centimetre waves

Before World War II, magnetron valves as described had been developed to the point of yielding a few capricious watts The efficiency was low, and the prospect of getting kilowatts out of them cannot have looked too hopeful Clearly, therefore, the required generator, if it is to be of any use in radar, had to be able to pour out such floods of energy that an infinitesimal fraction would be enough to give a useful signal with a crystal detector under unfavourable conditions.

In July 1940, a research group under Professor J. T Randall at Birmingham University was reported to have developed a magnetron valve Only a few inches in diameter and weighing barely 2 pounds, the output of this valve at a wavelength of 9 centimetres was about 500 kilowatts. It was doubtless a remarkable development and at once solved the much vexed problem of a high power microwave generator.

The power of the magnetron, however, is not continuous but is released at such a phenomenal rate in very brief pulses occurring some hundreds of time per second In design, it is incredibly simple, much more so than some of the valves in an ordinary broadcast receiver It is essentially the same as that already shown in Fig 1, the only obvious development of importance being that the resonant "circuits" are formed of the anode itself At such wavelengths the ordinary coil-and-condenser tuned circuit more or less vanishes, leaving only a metal hollow or cavity A number of such cavities are cut around the anode as shown in Fig 2, dividing the internal surface of the anode into the same number of segments Current oscillates around each cavity as indicated by the dotted line, so that at any given moment adjacent segments are of opposite polarity To ensure that this mode of oscillation is the only one occurring, each segment is metallically linked to its next neighbour but one The output power which, if continuous, is enough to light 8,000 60-watt lamps or cover the British Isles from 10 main broadcasting stations is drawn off by a loop as big as the curl in a safety pin

The outside of the anode is formed into fins for air cooling, and the only feed connections are the two filament leads and the H T (of the order of 25,000 volts) The emission of the filament is about 40 amps, and the efficiency of the valve is 50 per cent The flat shape enables it to be placed between the poles of a powerful permanent magnet

Among the radar systems for which the cavity magnetron provided the microwave generator can be mentioned new types of early warning stations, less conspicuous than the original "Chain" and giving more accurate bearings and heights and better low-flying cover, similar improvements in naval and military gun laying and searchlight control; AI for enabling fighter aircraft to locate their targets miles away in dark and fog; ASV for locating U-boats in similar circumstances (the lack of this alone might easily have cost us the war), H2S that showed the bombers their targets regardless of visibility, and the later refinements of Oboe by which the position for release of bombs was controlled from base.

NOISE AND ITS INSULATION IN BUILDINGS

KARMAVIR MITAL

INTRODUCTORY

NOISE and its effects. Noise is a by-product of modern civilization. It is the curse of the steel age. Clashing steel and thundering machinery, noisy vehicles and roaring trains, shrill whistles and shouting horns, all these go to make a modern city a veritable sea of disagreeable sounds in which the citizen has to pass his daily life. With the spread of industrialization, the calm of the country-side is slowly giving place to the buzz and clatter of 'civilized' life. The larger the city the more difficult it is for the average man to get a quiet corner. The man who can afford a quiet corner in Allahabad will probably find himself in a noisy street in Calcutta or Bombay. Only the richest can indulge in the luxury of peaceful surroundings in London or New York.

It was, therefore, natural that the demand for measures against noise was first made in a city like New York where the first scientific investigation of the problem was undertaken. For the first time a comprehensive survey of noises and technical proposals for their abatement were made.* Since then the problem of noise abatement has been an interesting subject of study by acoustical engineers, so that now it is definitely possible to protect the citizen from the adverse effect of noise first by trying to minimize the noise at the source, and, second by making noise-proof buildings. It is the second aspect of the problem that we propose to discuss here.

Noise can best be defined as a disagreeable sound. It depends to some extent upon the nature and the mood of the individual. Music of one can be noise of the other. Your radio can be your neighbour's headache, and he has as much right to be protected against it as you have to hear it. For, the effect of noise upon the health of human beings is very detrimental indeed. According to investigations by medical men, sound affects motor functions such as strength of grip and reaction times, and interferes with cerebral functions such as ability to perform psychological intelligence tests and to carry out multiplication sums. Breathing and pulse-rate are altered and blood-pressure is increased. General efficiency in work is greatly affected, and tests in factories have revealed increased output by workers due to reduction of noise.

Importance of sound-proofing. A factory building often contains the machinery as well as the administrative offices, and it is of supreme importance that the noise of the running machinery should not interfere with the efficient working in the offices. The hospital apartments should be so constructed that not only the noise outside in the streets is eliminated but also the crying and shrieking in one room are inaudible in the other. In big offices the noise of type-writers in one room should not be heard in the adjoining rooms. All this is possible if apartments are acoustically insulated from each other and it is here that the sound engineer comes to the help of the building engineer. It is only during the last twenty years that the subject has been investigated systematically, and many of the old notions of architects about sound-proofing have been definitely proved to be misconceptions. For example, there was a popular notion, held till quite lately, that materials and methods which are effective as heat insulators are also effective as sound insulators. In general, nearly all porous materials are good heat insulators; they are also good sound absorbers. But for that reason they are not necessarily good sound insulators, and many of them when used without understanding the principles of sound insulation prove to be quite ineffective.

We shall first deal with some fundamental definitions and units of noise measurement necessary to comprehend the basic principles of sound insulation, and then methods of sound insulation will be discussed.

DEFINITIONS AND UNITS OF NOISE MEASUREMENT

Intensity and loudness of sound. Intensity of sound of a definite tone, *i.e.*, of a wave of definite frequency, at a point is defined as the rate of flow of energy across a unit area at that point. It is proportional to the square of the amplitude (of displacement, velocity or pressure). Intensity is thus measured in energy units as ergs per sq cm.

Loudness of sound is a physiological sensation and is found to depend upon intensity. Intensity which is a physical measure of a particular characteristic of the sound wave is the stimulus, whereas loudness is the resulting sensation. But equal increments in intensity do not mean equal increments in loudness. The mathematical relation between the two is governed by a law in psycho-physics known as Weber-Fechner law which applies within limits

* "City Noise", Noise Abatement Commission, Department of Health, City of New York (1930).

to all the sense organs It states that equal increments of sensation are associated with equal increments in the logarithm of the stimulus If L is the loudness difference as perceived by the ear between two sounds of intensities I_1 and I_0, then

The unit of L is a 'bel'. A more convenient unit is a 'decibel' such that

$$L = 10 \log I_1/I_0 \text{ decibels} \ldots \quad (1)$$

This means that a thousand times increase in intensity of sound results in an increase of loudness of three bels or thirty decibels It coincidentally happens that 1 db (decibel) is approximately the minimum change in loudness that the human ear can perceive under average conditions.

Sensitivity of the ear The human ear can hear sounds of frequencies lying between 20 and 20,000 cycles per sec. All frequencies lying outside this range are inaudible. Further, the sensitivity of the ear, *i e*, the minimal loudness it can detect, varies

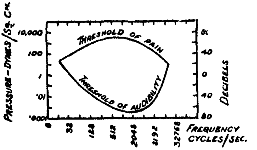


FIG 1.

with frequency Also for every frequency there is an upper limit to loudness beyond which the ear cannot hear properly but experiences pain The frequency-sensitivity graph (Fig 1) for hearing illustrates the behaviour of the ear very admirably

The frequency of the tone in no. of cycles per sec is indicated along the abscissa and the intensity of the tone (in amplitudes of pressure in dynes/sq. cm) on the ordinate Along the ordinate are also given loudness levels in dbs, being only a different unit for intensity, defined by equation (1) The lower curve shows the minimal threshold of audibility for tones of different pitch (or frequency) for an average person with normal hearing. The upper curve gives the upper limit of audibility or the threshold of feeling or pain, as it is called, because at this stage the sound becomes too loud and the ear begins to feel the sensation of pain The range of response of the ear is maximum for a tone of frequency in the neighbourhood of 2,000 cycles per sec., and the ear is most conveniently responsive to a frequency range of 6,500 cycles, *viz*, from 500 to 7,000 cycles per sec. It is this range which is most important in noise analysis and measurements Tones from 100 to 10,000 cycles per sec are, however, to be considered as they can produce distressing noise

Measurement of noise Noise is the combined effect of vibrations of countless frequencies at different levels of loudness With a modern apparatus for sound analysis, such as a microphone—amplifier system, it is possible to ascertain the wave form of the noise, to analyze it into its simple harmonic components, and to determine the distribution of energy in its various frequency bands. All this is, however, not necessary from the point of view of practical architectural acoustics It is enough to specify the loudness levels of the noise in the neighbourhood of certain standard frequencies such as 128, 512, 1024 and 2048 cycles per sec It is often convenient to evaluate the loudness in terms of a single number, as for example by specifying the sound level of a pure tone of, say, 1,000 cycles/sec which is judged to be of the same loudness as the noise Such evaluation does not give any indication of the quality of the noise

Several practical methods have been developed for the measurement of noise. A number of electrical instruments such as noise-meters, acousti-meters and audio-meters are now available for the purpose. A very simple method is described by A H Davis in which the loudness of noise is compared with the loudness of the sound of a standard tuning fork The method, apart from its simplicity, explains the principle of noise measurement very clearly, and hence it is described below at some length.

The fork or forks used in this method must be calibrated so that the sound level in dbs of each fork is known immediately after it has received a standard blow or excitation. Also it is necessary to know the rate of decay of the fork, *i e*, the no of decibels the loudness of the sound of the tuning fork falls in a second There are methods of determining both these factors with which we need not concern ourselves. Suffice to know that it is possible to have a tuning fork of known frequency, of known loudness of sound in dbs and of known rate of decay of loudness The observer who wants to measure a particular noise strikes the fork with a standard blow in the presence of the noise and at the same time starts a stop-watch. The fork is then held in front of the ear, moving it back and forth slightly, until the sound of the tuning fork falls down to a level where it is just masked by the loudness of the noise, at which instant the stop-watch is stopped. Knowing the time from the stop-watch we can find out the sound level of the fork just at the instant when it is just equal to the noise level Thus suppose a tuning fork gives an initial sound level of 66 dbs and

that its loudness decays at a rate of 1 1 db per sec then if the fork remains audible for 20 secs in the presence of the noise, it means that the noise level at the frequency of the fork is 66-22 or 44 dbs

In order to have a proper idea of the quality of the noise forks of frequencies 128, 512, 1024, 2048 etc may be taken and noise level determined by each fork for each frequency An average noise level may then be calculated if required

Some important noise levels Extensive noise surveys have been undertaken in U S A, and especially in the city of New York, to measure in decibels the loudness of various noises in streets, in factories, in private apartments and elsewhere. They are of utmost importance to the engineer engaged in the problem of noise insulation, for they give a clear quantitative idea as to how much noise can be tolerated in particular circumstances and how much is to be suppressed The following table gives the various types of noises that one comes across and their sound levels The data have been taken from American sources and, by their very nature, are in no way absolutely accurate. They are of advantage only to give an idea as to the levels of various tolerable and intolerable noises The zero level is taken to be the threshold of audibility below which the average ear does not detect any sound

TABLE I

	db				db	
	130–120	THRESHOLD OF FEELING			130–120	FACTORY NOISE
	120–110		AEROPLANE 18' FROM PROPELLER	HAMMER BLOWS ON STEEL PLATE	120–110	FACTORY NOISE
	110–100				110–100	FACTORY NOISE
	100–90		SUBWAY LOCAL STATION WITH EXPRESS PASSING	BOILER FACTORY	100–90	FACTORY NOISE
STREET NOISE	90–80	LOUD RADIO IN HOME	NOISIEST SPOT AT NIAGRA FALLS	ELECTRIC POWER SUB-STATION NOISY FACTORY	90–80	FACTORY NOISE
STREET NOISE	80–70		AVERAGE MOTOR TRUCK BUSY STREET TRAFFIC	AVERAGE FACTORY LOCATIONS	80–70	NON-RESIDENTIAL BUILDINGS
STREET NOISE	70–60	ORDINARY CONVERSATION	AVERAGE CAR	STENOGRAPHIC ROOM	70–60	NON-RESIDENTIAL BUILDINGS
STREET NOISE	60–50		BIG CROWDY RAILWAY STATION	MODERATE RESTAURANT	60–50	NON-RESIDENTIAL BUILDINGS
RESIDENCE NOISE	50–40	VERY QUIET RADIO	QUIET CAR	AVERAGE OFFICE	50–40	NON-RESIDENTIAL BUILDINGS
RESIDENCE NOISE	40–30	AVERAGE RESIDENCE		QUIET OFFICE	40–30	NON-RESIDENTIAL BUILDINGS
RESIDENCE NOISE	30–20	AVERAGE WHISPER	QUIET GARDEN		30–20	
RESIDENCE NOISE	20–10	RUSTLE OF LEAVES IN GENTLE BREEZE			20–10	
	10–0	THRESHOLD OF HEARING		QUIET STUDIO FOR MAKING SOUND PICTURES	10–0	

Tolerable noise levels The degree of noise insulation desired depends upon the purpose the room or the building in question is to serve It is obvious

that the degree of quietness desired in a motion-picture or radio broadcasting studio is much more than that desired in a music hall or a school room. Further it is meaningless to attain a very high degree of quietness in a public office where some noise is always inevitable. The following table, due to V. O. Knudsen, gives the approximate magnitudes of noise which will be accepted without complaint in different types of rooms and buildings.

TABLE II

	decibels
Sound recording and motion picture studios	6—8
Radio Broadcasting Studio	8—10
Hospitals	8—12
Music Studios	10—15
Apartments, hotels & rooms	10—20
Theatres, class rooms, libraries	12—24
Private offices	20—30
Public offices, banks, etc.	25—40

(To be concluded)

MEDICINE AND PUBLIC HEALTH

REMEDY FOR HEMOPHILIA

THE use of globulin and thrombin, both constituents of blood plasma, is now reported (*Science News Letter*, May 25, 1946) to have offered a successful remedy for hemophilia. Hemophilia is a well known hereditary disease whose victims lack a substance in their blood in consequence of which their blood does not clot when it is shed. Such patients are always in danger of bleeding to death from a slight cut or scratch. With the use of globulin and thrombin, patients of hemophilia can now have their teeth pulled and other operations performed without danger of bleeding. Even amputations and skin grafting of such patients have been successfully carried out without any untoward effect. Spread on or impregnated into sterile gauze, fibrin foams or absorbable cellulose, the anti-hemophilic agents are applied directly to the bleeding points. Hemorrhage has been found to be stopped in course of a few seconds.

Specific globulins which combine reversibly with iron and presumably transport it to the tissues of the body have been separated from blood plasma. Separation of globulins which dissolve water-insoluble fatty substances such as cholesterol, fatty vitamins such as vitamin A and fatty hormones, and also of globulin enzymes capable of splitting proteins and other complex chemicals has been successfully effected. Work on albumin is also of considerable interest in this connection. Albumin, developed for treatment of shock during the war, has already proved of great use in treatment of all types of reduced protein in the blood.

PENICILLIN IN CATTLE DISEASE

THE common mastitis due to streptococcus, the most prevalent disease among dairy cattle, is reported to lend to penicillin treatment. Experimental trials, to this effect, have been carried out, on an elaborate scale, by the veterinary scientists at the University of Wisconsin. Used in three large doses of 50,000 units each, at 24-hour intervals, penicillin cured 92 per cent of the tests, of which about half responded to single large doses. The drug proved generally helpful for dry and milking cows, causing little irritation and had no apparent effect on milk production. In chronic cases the response was better than in acute flareups. It is stated that it will often be practical to try first a single treatment wih 50,000 units. Failing this, a series of treatments can be used, administering three treatments of 50,000 units each at 24-hour interval, provided the cow is valuable enough to justify a prolonged treatment.

TRENDS OF RESEARCH IN THE ELABORATION OF SUPPRESSIVE ANTIMALARIALS

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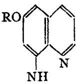
INTRODUCTION

IN an earlier paper[5], the author discussed the chemotherapy of malaria and various newer synthetic antimalarials up to the stage of discovery of Paludrine (VIII). Since then, several announcements have been made about the elaboration of 'suppressive antimalarials' from American sources and renewed interest has been created in the modern trends of investigation and research in this field. In view of the importance of malaria as a public health problem in India, it has been considered desirable to discuss some of the newer angles of study being pursued in this direction. As a result of intensive collaborative study between synthetic chemists, pharmacologists and clinicians, it appears that we are on the threshold of the discovery of a 'true prophylactic' against malaria, which will enable mankind before long to control the ravages of a disease which has been responsible for obliterating many civilizations. As far as India is concerned, the benefit would be immense, as will be appreciated from the recent statement of the Bhore Committee (Report, Health Survey & Development Committee, Government of India, 1946) which calculated the loss due to malaria as anywhere between 300-500 crores of rupees per year.

I. 8-AMINOQUINOLINES

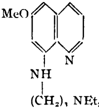
Plasmochin (I, R = Me, R′ = Et), the first synthetic antimalarial drug of major importance, was considered to be a true prophylactic. Apart from its unique effect on the gametes, specially of *Plasmodium falciparum*, it is a mild schizonticide for *P. vivax* and *P. malariae*. The potential toxicity, however, imposed restrictions on the scope of its clinical use. Demethylating plasmochin and replacing the



Me.CH $(CH_2)_3NR'_2$
R = H or Me
R′ = Me or Et

(I)

diethyl group of the basic chain by dimethyl group, 6-hydroxy-8-(δ-δ-dimethylamino-α-methyl butyl) amino quinoline (I, R = H, R′ = Me) was obtained in Germany in 1938. The compound under the trade name of "certuna" was tried in human malaria and was found[1] to be less toxic than plasmochin, but it was not found to possess that characteristic as demanded from a compound to be used as a suppressive agent. A lower homologue of plasmochin, 6-methoxy-8-(γ-diethylamino propyl) amino quinoline (II), is also a drug of considerable importance[2,3].

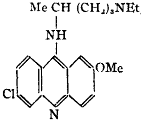


(II)

This product possesses the general characteristics of plasmochin but does not lead to the formation of methaemoglobin—one of the main drawbacks of plasmochin[4]. The drug would destroy the sporozoites at least of *P. vivax* and *P. falciparum* when taken in harmless doses. As these two species of parasites are of prime importance in the epidemiology of malaria, investigations on compounds of the series would be of considerable significance.

II. 4-AMINOQUINOLINES

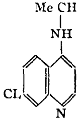
Patients with benign tertian (vivax) or quartan (malariae), who receive adequate therapy with atebrin (III)-a 4-amino benzoquinoline derivative, will have the gametocytes destroyed along with the trophozoites



(III)

and thereby, become non-infectious. But the malignant tertian (falciparum) patients remain infectious as the sexual form (gametocytes) in these cases are practically resistant. Plasmochin, a 8-amino quiloline

derivative, has little action on trophozoites of any species but possesses the unique property of devitalizing the infecting stage of the various malarial parasites, particularly those of *P falciparum* The question naturally arises whether a suppressive agent may be found in quinolines having alkylamino substituents in both 4 and 8-carbon atoms (Mukerji and Basu[5]), or, even in suitable 4-amino quinoline derivatives. Compounds of the latter type are known[6, 7, 8] and, as a matter of fact, it has been recently recorded[9, 10] that amongst the antimalarials studied in the United States of America during the war period, 7-chloro-4-δ -diethylamino-α-methyl butyl) amino quinoline (IV) is being found to be an effective suppressant (*cf* Basu and Das Gupta[11]) It is well tolerated and does



(IV)

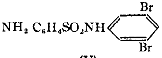
not colour the skin Administration of this drug for only one or two days is sufficient to cure *falciparum*, malaria, or to cause abrupt termination of clinical attacks of *vivax* malaria. If this finding be actually verified on extensive clinical trials, it would again indicate that the synthesis of a *chemo-therapeutic* compound demands not only intensive chemical research, but a close and co-ordinating team work amongst chemists, biologists and clinicians for systematic laboratory experiments as well as trials on patients undergoing malarial therapy It would now be of some worth to give a clinical trial to other compounds and derivatives of the above 4-amino quinoline type Of course recently non-basic quinoline compounds like 2 4-dihydroxy-3-quinolyl methyl ketone[12] derivatives, are also being found to exert an antimalarial activity

III Sulphonamide Derivatives

Since the discovery of 'prontosil', attempts have been made to find the efficacy of this group of drugs in malaria (*cf* Das Gupta and Chopra[13]) The drug was noticed by Niven[14] to be less potent in effecting cures than quinine (*cf* also Yamamoto[15]) Sinton *et al*[16] found in *p*-benzylaminobenzene sulphonamide a true causal prophylactic in induced *P* falciparum infection Chopra, Das Gupta, Sen and Hayter[17] again noted that prontosil had destructive action on the sexual as well as asexual forms of *vivax* and *malariae* parasites, but only on the asexual forms in the case of *falciparum* All these indicate that we may find in sulphonamide groups of drugs a compound that might behave as a true prophylactic In working with Rhesus monkeys inoculated with *P* knowlesi, Coggeshall and Maier[18] noticed that sulphanilamide completely eradicates the parasites from the animals whereas quinine and atebrin have no such radical effect The respiration of *P* knowlesi is, however, inhibited by quinine as well as atebrin These *in vivo* and *in vitro* experiments may help in evaluating the potentiality of a new sulphonamide drug

It may be recorded here that the most fundamental fact about sulphonamides is that they are general cell inhibitors and that their anti-malarial activity is again inhibited[19] by *p*-amino benzoic acid indicating, thereby, that the malarial parasites also need this chemical entity (*cf* Seeler, Graessle and Dussenbery[20]) The effect of quinine and atebrin is, however, not antagonized by *p*-amino benzoic acid It is apparent, therefore, that quinine and atebrin act on plasmodia through a different mechanism Sulphonamide drugs are known to exert their characteristic physiological action by interfering with the utilization of *p*-amino benzoic acid an essential vitamin for the growth of many micro-organisms But there are observations on record (*cf* Sevag and Shelburne[21]) that tend to show that this inhibition of growth by sulphonamides is due to the inhibition of the bacterial respiratory enzymes Such phenomenon has also been recorded in the case of malarial parasites where sulphonamide drugs have been found to inhibit markedly the oxygen consumption of *P knowlesi* (Coggeshall[22] , and Velick[23]) In the case of malarial parasites, however, no correlation is being found between the effect of various antimalarial drugs on the respiration of the parasites *in vitro* and their effect in experimental infection Thus sulphathiazole inhibits the respiration of *P inui* and *P cynomolgi* to a greater extent than *P knowlesi*, whereas *in vivo* the drug has been found by Coggeshall and Maier[18] to be more effective against *P knowlesi*. It is beyond the scope of this review to narrate in detail how the drugs bring forth respiratory inhibition , but it may be mentioned in passing that sulphonamides are known to inhibit certain dehydrogenases and carboxylase, and it is this inhibition of coenzyme—protein type of enzyme, that results in the final growth inhibition (*cf.* Laves[24], MacLeod[25] and Sevag *et al*[26]) On the above hypothesis, a sulphanilamide derivative containing a group as present in co-enzyme complex may exert an enhanced activity (*cf* Mudd[27]), as is found for example, in the case of sulphapyridine, sulphathiazole or sulphadiazine. All these drugs have been tried in human malaria cases, but none has been found superior to quinine or atebrin as noticed by Chopra[28] *et al*, Schwartz and his collaborators[29] and Coggeshall, Maier and

Best[30] respectively Sulphadiazine with a total dose of about 80 gms over a period of two weeks was, however, found by Johnson[31] to be of some curative efficacy Atebrin which is not antagonized by *p*-aminobenzoic acid has also an inhibitory action on the respiratory enzymes (Haas[32]) The problem suggests itself how a sulphonamide group of the above nature and having no inhibitory action by *p*-aminobenzoic acid, would behave against malarial parasites Compounds, such as *p-amino* benzene sulphon—3′, 5′ dibromophenyl-amide (V)[33] and *p*-amino methyl benzene sulphonamide (marfanil)[34], are



(V)

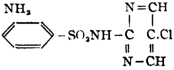
now known which are not affected by *p*-amino benzoic acid From these as well as from the fact that quinine acts on the malarial parasite in the form of the free base (Mayeda[35]) it appears to be of interest to study compounds of the type (VI), where X = NH_2,

$$\begin{array}{rl} & N-C\ \ B \\ & \ \ |\ \ \ \ \ \ | \\ X\ C_6H_4SO_2NH- & C\ \ \ CH \\ & \ \ \|\ \ \ \ \ \ \| \\ & N-C\ \ R \end{array}$$

X = NH_2, NH_2CH_2, or, Cl
B = H, or, dialkylamino alkylamine

(VI)

NH_2CH_2, or Cl, and B = H, or (CH_2) NR_2 As a matter of fact, various compounds of this nature have already been prepared and are under pharmacological investigations Recently, a compound 2-(*m*-amino-benzene sulphonyl amino)-5-chloro-pyrimidine (VII),



(VII)

is already undergoing field trials in U S A for the verification of its superiority over known antimalarials as a suppressive agent Other compounds in sulphonamide group exerting this characteristic action by mechanism quite independent of *p*-amino benzoic acid may accordingly be prepared and tested for antimalarial activities

IV. Amidines

Glyn-Hughes, Lourie and Yorke[36] first noticed an antimalarial activity in a new type of compounds, undecane 1.11 diamidine. Later on Yorke[37] and Fulton[38] demonstrated the activity in simpler compounds 4 4′-diamino stilbene and 4 4′ diamidino diphenoxy pentane Both had an inhibiting action upon *in-vitro* respiration of simian parasites In human malaria though certain activity is noticed against *P vivax* infections, *P falciparum* remains unattacked A new type of compound, N_1-*p*-chloro-phenyl-N_5-*iso*-propyl biguanide (VIII) has been re-

$$\begin{array}{l} Cl\ C_6H_4\ NH-\underset{\underset{NH}{\|}}{C}-NH-\underset{\underset{NH}{\|}}{C}-NH-CH.Me_2 \end{array}$$

(VIII)

cently described by Curd and Rose[39] and is being claimed to prevent clinical symptoms of malaria from appearing when taken once a week Until test report on field trial in endemic area is forthcoming, work on suitable substitutes would go on as usual

Summary

It appears that so long the ultimate extinction of malaria infection has been due to the activation of the body's immune mechanism than to the administration of drugs The existing drugs though would not prevent a person from contracting infection, they will check the multiplication of parasites sufficiently so that persons will not develop clinical malaria during the period in which they are ingested. But for a true prophylaxis a product is wanted that would eradicate all the malarial parasites from the body and/or prevent the multiplication of the parasite when ingested into the body Recent researches tend to show that we may have in at least 4 groups of compounds, namely (*a*) 8-and (*b*) 4-dialkylamino quinoline derivatives, (*c*) sulphonamide derivatives, and (*d*) amidines, drugs that might act as a true prophylactic It may be said that days are not far away off when malaria would be controlled by synthetic medicaments produced by the joint efforts of divergent groups of scientists

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BOOK REVIEWS

Action of Radiations on Living Cells.—By D. E Lea Cambridge University Press, 1946 Pp xii+402 Price 21 *sh* net

Action of radiations on living cells are many and varied Probably the most important of them, necessary for the continuation of life on the earth in the form known to us, depends on the photosynthesis of carbohydrates by the absorption of certain components of solar radiation by plant cells containing chlorophyll Thanks to the use of carbon isotopes as trace elements, the successive steps in photosynthesis is being gradually unravelled There are other effects of radiations, like phototropism, photoperiodism etc whose mechanisms are not yet understood The standard treaties on this subject is the two volumes of 'Biological Action of Radiations' edited by Duggar In the book under review, the author has a very limited objective, which is to give a more or less quantitative account of certain of the simplest and most fundamental actions of X rays and other ionizing radiations on living cells These may produce by decomposition different kinds of chemicals which affect adversely the living tissues The amount of ionization per unit volume required for this purpose can be calculated There are however a number of biological effects which include the inactivation of viruses, bacterial destruction, modification of genetical stability of higher organisms, and lethal effect on their propagation, which require much smaller doses of radiation It is the purpose of this book to show how all these effects can be interpreted from a unified quantitative stand point, on the theory that they are due to modifications introduced by absorption of these radiations in the large nucleoprotein molecules which form the common key material or code script, through which the reproduction, through successive generations, of these organisms is achieved

The book contains two valuable introductory chapters One on the physics of the different kinds of radiations, charged like alpha and beta particles, protons, and uncharged like neutrons, X rays and gamma rays which either directly or indirectly produce ionizations in absorbing media like living tissues For purpose of rounding off, the comparable effect of ultraviolet radiations on living tissue is also considered, though it is not possible to measure the dosage of ultraviolet rays in units by means of which the effect of all the other radiation can be evaluated, which is called the roentgen (r) Useful tables are provided for the calculation of the ionization produced or the equivalent energy dissipated in different tissues corresponding to one 'r' unit of different kinds of radiation

In the other chapter, a brief account is given of the mechanism of heredity, which is intended to provide the reader who is not a geneticist, with the

minimum amount of information on the principles and terminologies of the subject, which is necessary for the understanding of the subsequent chapters As is well known the hereditary properties of an organism resides in the nucleus of each individual cell. The latter is made up of chromosomes, which consists of thread like structures of nucleoproteins In the chromosomes are located the genes, the physical entities corresponding to the Mendelian characters of the organism Changes in individual genes, in their number or positions in the chromosome causes changes in the character of the organism Such changes can occur spontaneously, as was first discovered by de Vries and named by him mutation They occur at a frequency of 10^{-1} to 10^{-6} per generation Different physical and chemical methods can be used to increase the rate of spontaneous mutation One of the most convenient method, which is capable of giving quantitative results, was discovered by Muller in 1927, it consists in irradiating these organisms with X rays and other ionizing radiations This method is chiefly used for quantitative investigations on induced genetic changes in organisms

The action of the ionizing radiation in inactivating viruses, killing bacterias, in producing visible and lethal mutations in higher organisms are the subject dealt with quantitatively in this book It is shown that the effects observed depend only on the total quantity of radiation which is absorbed by the living organism, and is independent to a large extent of the time period over which the radiation is spread and the wavelength or other characteristics of the ionizing radiations Only with soft X rays, neutrons and alpha particles, some significant variations dependent on the characteristics of the ionizing agents has been observed These observed effects can be quantitatively interpreted on the target theory, according to which they are due to single ionization produced by the radiation either in the nuclear portion of the organism, or in their immediate vicinity resulting, either in the alteration of a gene or production of breaks or other large scale alteration in the chromosomes In some of the large sized chromosomes, as in *Tradescantia* etc such chromosome breaks have been photographed, in others the effect of irradiation on germ cells is inferred from mutations observed in offsprings raised from them If the population raised from the irradiated germ cells is small compared to that raised from the controls, then it is inferred that this is due to lethal gene mutation or large chromosome structural changes The inactivation of viruses and the killing of bacteria are attributed to the former cause The viruses are extremely small parasitic bodies which can only reproduce themselves when introduced in suitable plant or animal host organisms. The smallest of them consist of crystalline nucleoprotein molecules, supposed to be identical in structure with gene molecules, and which act in a similar way as autocatalyst in producing their own replicas out of the cytoplasmic material of the host One of the success of the target theory is that it enables from the rate of inactivation under irradiation, the calculation of the size of these virus molecules, which are in agreement with the estimates obtained by other methods

In those organisms in which chromosome structural changes as well as lethal action have been investigated, namely *Drosophila* sperms and eggs, *Tradescantia*, pollens, bean root tips, there is fairly strong, though at present circumstantial evidence, for the view that the main cause of the lethal effect is the production of chromosome structural changes which leads to bridges at division, or genetic unbalance after division It is to be emphasised that sufficiently large dose of radiation given to any cell at any stage cause its immediate destruction But the effect which have been discussed above are due to moderate doses of radiation, of the order of 10^2 to 10^3 r units, which produce a rather slight amount of chemical action in the cell as a whole, but are able to cause the death of a cell, not immediately but only at or following nuclear division

How far are these results applicable to rapidly dividing animal tissues including malignant cancer tissues? In the book it is only slightly discussed, and the difficulty of making direct investigations on animal cells, with their large chromosome numbers and small sizes is pointed out

Recent biochemical investigations have shown that one of the main factors for normal growth is the supply of nucleic acids (desoxyribose and ribose) in the cell Chromosome reproduction and protein synthesis is dependent on the presence of these substances respectively When the relative supply of the two nucleic acids is altered, the rate of cell proliferation may be raised to such an extent, that the growth becomes uncontrolled or malignant. It is found that doses of radiation which are not harmful to normal tissue cells are destructive to the rapidly dividing malignant cells The probable cause of this, in the view of the author, is the same as that has been found effective in the destruction of dividing cells of *Drosophila*, *Tradescantia*, etc, *viz*, that chromosome structural changes, produced in a cell at any stage in its life, will lead to cell degeneration at the time of division only Normal cells which do not divide are therefore less liable to degeneration under radiation than rapidly dividing malignant cells

The reviewer who is a physicist has found the book very instructive and illuminating It is gratifying to see how quantitative laws based upon well defined physical concepts are found applicable to the interpretation of genetic modifications of organ-

isms under ionizing radiations The book contains many tables and graphs which will enable experimenters on this subject to interpret their results quantitatively, without requiring any knowledge of the mathematics involved in the deduction and application of the necessary formulas The book will be found useful to the workers on the subject Its usefulness to nontechnical readers would be enhanced if an introductory chapter had been included containing a preview of the whole subject

D M B

On Humus and the Earthworm—The Formation of Vegetable Mould.—By Charles Darwin First published in 1881 Republished in 1945 with a preface by Sir Albert Howard Pp 153 with 15 figures Faber and Faber Ltd, London, 1945 Price *8s 6d*

THE importance of earthworm was recognised about 2000 years ago when Aristotle regarded them as "The intestines of the earth" The first systematic study may be attributed to Gilbert White, the noted English naturalist of the seventeenth century Recent works of Dr T F Barett, Dr Oliver, Mr W H. Upson and others in America, on the direct application of earthworm in agriculture and soil improvement, have led to the establishment of large scale earthworm industry in the United States of America The subject of earthworm is now once more in limelight and is one of the postwar rehabilitation jobs in America Darwin's work on earthworm was first published in 1881, after long and painstaking close observations and experiments over forty years The publication, however, was ahead of its time and failed to influence the agricultural teaching and research of the period, as the agricultural science (of about the end of the nineteenth century) was still a branch of chemistry dominated by Liebig and Rothamsted School—the great advocates of chemical farmings at their zenith in the period

In a suitable region the number of earthworms may exceed more than two and a half million per acre, weighing 1400 pound They are constantly swallowing great quantities of earth containing minerals, vegetable remains, animal residue and microscopic organisms. In their journey through the long alimentary canal they are grinded and disintegrated with the help of sand, and with abundant secretions poured in, which exert solvent and chemical action ; ultimately they form an intimate mixture Finally, they are ejected along with some animal hormones outside, to form a crumbly and finely conditioned top soil rich with all the elements necessary for plant nutrition in water-soluble form. Thus, this top layer—"the placenta of life"—is virtually a "copy-righted product of earth worm" Earthworm contains 1 2 to 2 per cent of nitrogen and decomposes readily to furnish plant food as it dies. They are, moreover, so many tiny labourers aerating the soil, making it more porous and absorbent The re-publication of Darwin's work at this stage with an introduction by Sir A Howard linking up with the recent work on earth worm, may lead again to a war in full swing between the organic and inorganic manure with a balance in favour of the former

The book shows a close observation of the normal habitat of the earthworms, their nocturnal habit, their power of sensation, distinguishing between light and darkness, heat and cold, sensitiveness to vibration and touch, their feeble power of smell, and morphological structure It discusses the depth to which earthworms penetrate, excavate and build up the burrows, the materials and manner of plugging the openings and ejecting the castings The physical process of the gradual disintegration of small particles of rock and the process of the digestion of plant and animal residue with the help of secretions and the neutralization of the ultimate product with calcareous secretions from the oesophagus have been carefully followed in the text

An interesting observation on the earth worms has been their role in undermining pavements by their gradual subsidence as a result of the removal of underlying soil in form of cast According to the author no building is safe in this respect unless the foundation reaches a depth of 6-7 ft where earthworms do not operate

Earthworms however, are of archeological importance They have protected and preserved for a long period objects not liable to decay like Roman wall, have kept up, many elegant and curious tesselated pavements and other ancient ruins in England by burying them with their castings, aided often by their being washed or blown from the adjoining land.

In humid region, soil about the thickness of about two inches are annually brought up to the surface Part of this rolls, flows or is washed over and forms the top dressing The gradual disintegration of rocks takes place, partly by the action of carbonic acid but to a greater measure by the humus acid This humus acid, according to the author, is probably hastened by the digestion of many half-decayed leaves which the earthworm consumes.

S. R. B.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters]

NUTRITIVE VALUE OF GROUNDNUT MILK

GROUNDNUT (*Arachis hypogæa* Linn) which has an oil content ranging from 40-50 per cent and a protein content of about 30 per cent readily yields a milk on grinding the white kernel to a fine paste, which is then boiled with more water The flavour, taste and digestibility of the milk are improved by first steeping the kernels (with the silver skin) in water and allowing it to undergo germination for 1-2 days The milk prepared out of the germinated kernel (after removing the silver skin) has the following average composition—total solids, 10 5%, protein, 3 7%, fat, 3 5%, carbohydrate, 3 0%, minerals (ash) 0 3% Vitamin B_1 content of the milk is 45 g in 100 c c , and nicotinic acid, 0 9 mgm in 100 c c

Groundnut milk thus prepared has an attractive colour and a thick consistency in spite of the relatively low solid content. It has a sweet, agreeable taste, but the flavour is reminiscent of groundnut The oil in the milk has a tendency to turn rancid, the rancid flavour increasing with time. The milk is not very stable and tends to turn into a curd in a few hours The curd also sours (the same way as cow's milk curd) after some time These defects can be largely overcome by (1) addition of a natural or synthetic anti-oxidant and boiling the milk with vigorous stirring and (2) carefully adjusting the reaction of the milk to *p*H 6 2 with sodium bicarbonate or lime water and seeing that this reaction is maintained during boiling The flavour of groundnut is a volatile principle and can be removed by vigorous steaming. A simple method of preventing the development of rancidity and one which also increases the stability of the milk is to add about 20% germinated soya-bean kernel at the time of pasting. Soya.-bean contains the desired anti-oxidant and its protein makes a good supplement to groundnut protein. Similar anti-oxidants are present in certain cereals, oat meal and so forth, but among those so far tried, soya-bean gives the best milk By adjusting the reaction, the stability of the milk can be greatly improved

The biological value of the groundnut milk protein has been determined by both the rat growth method and by the nitrogen balance method According to the former, the average increase in weight per gram of protein intake, is as follows raw, whole groundnut, 1 58 gms: milk from fresh groundnut, 1.45 gms; milk from germinated groundnut, 1.75. This would appear to be encouraging as compared with an average of 2 0 gms increase as obtained with cow's milk protein The results by the balance sheet method, as compared with the corresponding figures for cow's milk and soya milk, are as follows --

	Digestibility coefficient	Biological value	Net assimilation
Raw groundnut	82 7	50 0	41 3
Milk from germinated groundnut	96 2	55 4	53 3
Cow's milk	89 7	82 8	74·3
Soya milk	90 9	79 2	72 0

The biological value of protein of groundnut milk is rather low and there is a suggestion that the protein requires to be supplemented with another high class protein so as to raise its biological value

The overall vitamin B-complex value of germinated groundnut milk was compared with that of cow's milk Rats first depleted of their reserves of B-vitamins by feeding on B_1-Vitamin-free diet for two weeks were then fed on the same diet supplemented with 10 c c of groundnut milk in one series and 10 c c of cow's milk in another There were also controls on exclusively B-vitamin free diet The average increase in weight over two months (from the commencement of milk administration) was as 66 gms in the case of cow's milk and 54 gms in the case of groundnut milk The controls died in about three weeks The B-vitamin complex of groundnut milk may be estimated as being 80% of that in cow's milk

The supplementary value of groundnut milk when added to the poor South Indian diet was studied at different levels The composition of the diet was similar to that used by Aykroyd and Krishnan[1] It was found that whole average increase in weight in the case of controls (South Indian diet alone) in the course of eight weeks was 44 gms , the corresponding increase with a supplement of 6 c c per day of groundnut milk was 49 gms and that with 9 c c was 43 gms These observations would show that groundnut milk, by itself has a very poor supplementary effect The slight diminution of effect observed on increasing the level of supplement is rather inexplicable and more work is needed to throw light on this aspect

Systematic experiments are now in progress to determine the nature of the additional factors needed to raise the supplementary value of groundnut milk to nearly the same level as that of cow's milk

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[1] Aykroyd and Krishnan, *Ind Jour Med Res*, *24*, 1093, 1937

SOME ANILS AND DIACYLS OF ETHYLENE-BIS-N[1]-SULPHANILAMIDE AND SOME N[1]-SULPHANILAMIDO-ALIPHATIC ESTERS

ETHYLENE bis-N[1]-sulphanilamide was reported by us[1] in the note on the preparation of some alkylene-bis-sulphanilamides Some Schiff's bases and diacyl derivatives of the same have now been prepared Molecular proportions of ethylene-bis-N[1]-sulphanilamide and the aromatic aldehyde were made to react by fusion at suitable temperatures Products were purified by removing the starting materials and they are tabulated in Table I

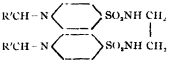

TABLE I

	R'	m p °C
1	C_6H_5-	241--242
2	m-$NO_2C_6H_4$-	211—212
3	o-$(OH)C_6H_4$-	245
4	$C_6H_5CH=CH$-	172
5	p-(OCH_3) C_6H_4-	168—169
6	α-(OH) $C_{10}H_7$-	275—277
7	3-(OH)-4-(OCH_3) C_6H_3-	237° (decomp)
8	C_6H_5 CH_2-	133
9	C_4H_3O-	225

Harris and Klein[2] and Miller *et al*[3] reported that the activity of straight chain aliphatic acyl derivatives of sulphanilamide increases with the increase in number of carbon atoms in the acyl residue from C_2 to C_7 It appeared interesting therefore to prepare diacyl compounds of ethylene-bis-N[1]-sulphanilamide by subjecting the bis-sulphanilamide to the action of acid chlorides of monocarboxylic aliphatic acids (Table II)

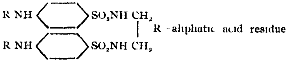

TABLE II

	R	m p °C
1	CH_3CO-	275
2	CH_3CH_2 CO-	271
3	$CH_3CH_2CH_2$ CO-	262—263
4	$(CH_3)_2CHCO$-	256
5	$(CH_3)_2CHCH_2$ CO-	202
6	$CH_3(CH_2)_4$-CO-	206
7	$CH_3(CH_2)_5$-CO-	182

Trefouel *et al*[4] have reported that N[4]-sulphanilamido-acetic acid is pharmacologically active Patents[5] have been taken for N[4]-sulphanilamido-acetic ester and its acid as also for N[4]-sulphanilamido propionic acid By reacting various aliphatic bromoesters with sulphanilamide, the corresponding N[4]-sulphanilamido aliphatic esters have been obtained which were further hydrolysed to give the corresponding acids (Table III)

TABLE III

No	Name	m p of the esters °C	m p of the corresponding acid °C
1.	N[4]-sulphanilamido acetic ester	136-138	245 (with decomp)
2	N[4]-sulphanilamido propionic ester	110°	180-181
3	N[4]-sulphanilamido butyric ester	117	172
4	N[4]-sulphanilamido malonic ester	171-172	236 (with decomp)
5	N[4]-sulphanilamido phenylacetic ester	126	189 (with decomp)

All the above compounds are awaiting pharmacological examination

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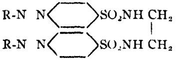
[1] Bami, Iyer and Guha, SCIENCE AND CULTURE, *11*, 269, 1945
[2] Harris, J. S., Klein, J. R , *Proc Soc Exptl Biol & Med.*, *38*, 78, 1938
[3] Miller, E , Rock, H J , Moore, M L , *J Amer Chem Soc* , *61*, 1198, 1939
[4] Trefouel *et al*, *Ann Inst Pasteur*, *58*, 30, 1937.
[5] Northey, E. H., *Chem. Rev.*, *27*, 118, 1940, F P 816988 (1937), 839711 (1939); B R., 470462 (1937)

SOME AZO-DYES OF ETHYLENE BIS-N[1]-SULPHANILAMIDE

BAMI, Iyer and Guha[1] prepared ethylene-bis-N[1]-sulphanilamide by reacting the potassium salt of acetylsulphanilamide with ethylene dibromide and hydrolysing the acetyl groups later. The two free-amino groups of this compound have now been tetrazotised and coupled with various aromatic hydroxy and amino compounds giving rise to bis-azo compounds (I) of the following structure



(I)

(where R is an aromatic hydroxy or amino radical)

Hydroxy and amino-azo, dyes tabulated below possess shades varying from light red to dark brown with poor solubilities in organic solvents. The compounds are awaiting pharmacological examination.

Aromatic hydroxy azo dyes

	Coupling agent	m p with decomp
1	Phenol	175°C
2	*p*-Cresol	150°
3	1 2 5-Xylenol	172°
4	*o*-Nitrophenol	171°
5	Salicylic acid	236°
6	Resorcinol	decomposes
7	Resorcinol ethyl ether	145°
8	Resorcinol methyl ether	192°
9	α-Naphthol	152°
10	β-Naphthol	258°

Aromatic amino azo dyes

	Coupling agent	m p with decomp
1	Aniline	185°C
2	*p*-Toluidine	above 135°
3	1 3 6-Xylidine	138°
4	Dimethylaniline	253°
5	*m*-Amino-phenol	176°
6	*p*-Anisidine	140°
7	Anthranilic acid	160°
8	*m*-Phenylenediamine	223°
9	β-Naphthalamine	210°
10	Naphthionic acid	above 250°

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[1] Bami, Iyer and Guha, SCIENCE AND CULTURE, *11*, 269, 1945

A NEW ELECTRONIC LEVEL (O_u^+) AT 51683 cm^{-1}, IN I_2 MOLECULE: CORDES BANDS.

CORDES[1] has recorded a large number of bands in the fluorite region in the absorption spectrum of iodine vapour. 53 of these included in one table are analysed by him into 8 different systems all involving transitions from the ground level to various excited states above 56,000 cm^{-1}. 110 more bands which are recorded in another table but were not analysed were regarded by him to probably form an extension of Pringsheim-Rosen[2], Kimura-Miyanishi[3] (P-R, K-M) bands which lie between 2000 and 2700 A.

This group of 110 bands consists obviously of two sets separated by a gap of 18 A. The first set comprises 94 of the bands at intervals of roughly 2A. It has been possible to derive a vibrational analysis of these bands which goes to show that they form a new system (different from the P-R, K-M system) involving a hitherto undiscovered upper level at 51683 cm^{-1}. The band heads which are not very sharp are well represented by the following equation

$$\nu = 51683 + (164.5v' - 0.6v'^2 - 0.0035v'^3) - (213.6v'' - 0.6v''^2)$$

The bands involve mostly $v''=0$, 1 and 2 progressions which are well developed. There are also a few bands involving $v''=3$ and 4 but all of them have high v' values. Both these characteristics are what one would expect under the experimental conditions and the relative values of the frequencies of vibration in the ground and excited states.

It can also be definitely shown that the initial state of this new system results from a combination of $I^-(^1S_0)$ and $I^+(^3P_2)$ and is to be designated as O_u^+ state in the case (c) type coupling which obviously obtains. The discovery of this new level leads to a satisfactory explanation of some of the fluctuation emission bands of iodine[4] as is shown in detailed communications on the subject submitted for publication elsewhere.

R K ASUNDI
P VENKATESWARLU

Benares Hindu University,
Benares, 16-6-1946

[1] Cordes, *Z f P*, *97*, 603, 1933
[2] Pringsheim and Rosen, *Z f P*, *50*, 1, 1928
[3] Kimura and Miyanishi, Sc Papers, *Inst Phys and Chem Res Tokyo*, *10*, 33, 1929
[4] Asundi and Venkateswarlu, *Nature*, *156*, 452, 1945

A CASE OF VIVIPARY IN *CARICA PAPAYA* LINN

IN *Carica papaya* the seeds are usually known to germinate after they have come out of the ripe fruit. But a case of viviparous germination was brought to the notice of the author some time back.

A fully ripe fruit, purchased from the local market, when cut into two, revealed quite a large number of seeds. Though most of these seeds were ungerminated and apparently normal, some of them were found germinating and they were brought to the author after the fruit was eaten up.

These germinating seeds were of normal size and appearance and were in different stages of germination, beginning from the peeping of the radicle, to a fully formed seedling with well-defined shoot and root systems. The stems (developed hypocotyl) of these seedlings were white, weak and tortuous like a thread having a maximum length of 2½ inches. These elongated stems were crowned by the pair of

first foliage leaves (out drawn cotyledons) which though yellowish and slightly rolled inwards, were of normal size The roots were slightly weaker and less developed than those in the normal seedlings, but still they showed well defined tap roots

FIG. 1

Some of the ungerminated seeds were sown in the soil and were found to germinate quite normally

The figure shows five of those viviparous seedlings in three different stages of germination

My thanks are due to Mr S Bhanja Chowdhury for kindly photographing the seedlings for me

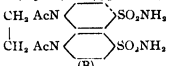
P SEN

Visva-Bharati,
Santiniketan, Bengal,
2-7-1946

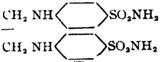
ALIPHATIC ACYLS OF ETHYLENE-BIS-N[4]-SULPHANILAMIDE

THE acyl derivatives of sulphanilamide are of interest because sulphanilamide is in part acetylated in animal body before excretion [1,2] The activity of N^4-acyl derivatives of sulphanilamide increases with the increase in the number of carbon atoms in the acyl chain upto 7 atoms but after that their activity ceases [2,3] Adams *et al*[4] have shown that acetyl sulphanilamide splits in the system with more difficulty than the higher acyl derivatives The ease of hydrolysis parallels the activity of these compounds.[5,6]

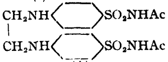
The diacyls (type B) of ethylene-bis-N^4-sulphanilamide[6] (I) listed below have been prepared by reacting it with the anhydride of acetic acid and the acid chlorides of propionic to heptoic acids. Acylation of (I) could lead to the formation of either N^4-(type B) N^1-(type A) acyl derivatives



(B)

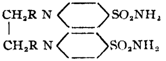


(I)



(A)

That acylation of (I) gave compounds of type B was proved by an independent synthesis of ethylene-bis-N^1-(N^1-acetylsulphanilamide), m p 191-93° (type A) by condensing N^1-acetyl-sulphanilamide[7] with ethylene dibromide Ethylene-bis-N^4-(N^4-acetyl-sulphanilamide) (type B) melted at 252-254° The diacyl derivatives were white amorphous powders, readily soluble in alkalis but insoluble in organic solvents and mineral acids



No	R	m p °C	Emperical formula	Nitrogen % Found	Calc
1	CH_3CO-	252-54	$C_{18}H_{22}O_6N_4S_2$	12 10	12 37
2.	CH_3CH_2CO-	235-236	$C_{20}H_{26}O_6N_4S_2$	11 20	11 60
3	$CH_3CH_2CH_2CO-$	266-268 (decomp)	$C_{22}H_{30}O_6N_4S_2$	10 40	10 98
4	$(CH_3)_2CHCO-$	243 (decomp)	$C_{22}H_{30}O_6N_4S_2$	10 50	10 98
5	$(CH_3)_2CH\ CH_2CO$	249 (decomp)	$C_{24}H_{34}O_6N_4S_2$	10 13	10 40
6	$CH_3(CH_2)_4CO-$	225	$C_{26}H_{38}O_6N_4S_2$	9 41	9 89
7	$CH_3(CH_2)_5CO-$	215	$C_{28}H_{42}O_6N_4S_2$	9 10	9 42

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Bangalore, 3-7-1946

[1] Mathias, Kohl and Lura, *Proc Soc Exptl Biol and Med*, **44**, 455, 1940
[2] Harris, and Klein, *Ibid.*, **38**, 78, 1938
[3] Fourneu *et al*, *Compt rend. Soc Biol*, **122**, 258, 1936
[4] Adams, Long and Johnson, *J Amer Chem Soc*, **61**, 2342, 1939
[5] Cooper, *et al*, *Proc Soc Exptl Biol and Med*, **44**, 455, 1940
[6] Bami, Iyer and Guha, SCIENCE AND CULTURE, **11**, 269, 1945
[7] Crossley, *et al*, *J Amer. Chem Soc.*, **61**, 2950, 1939

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. | OCTOBER, 1946 | No. 4

A PLEA FOR AN ASSOCIATION OF SCIENTIFIC WORKERS

SCIENCE can no longer be maintained as a profession of few elites in academic world engaged in leisurely pursuits far away from humdrum of the realities of life Even in a country like India, where scientific activities are greatly handicapped and consequently remain backward, seat of a scientific worker[1] is not limited any more to the four walls of a university laboratory In fact, a scientific worker today has more scope for utilizing his skill and earning his living in factories and fisheries, assembly plants and clinics than in the gloomy laboratories of the universities. Life of a scientific worker is being interwoven with the life of the common man With the broadening of the scope of a scientific worker, his status too is gradually enlarging The idea that there can be an individual worker in any domain of science working all alone in his laboratory is as obsolete today as that of an artisan trying to be completely self-sufficient At the same time, science, like other achievements of the mankind, does not depend on a few persons engrossed in abstruse thinking A laboratory assistant, a technician or a collector of statistical data is as much necessary for the progress of science as a skilled scientist. But it has become customary to regard the scientific achievements and products of science as the result of labour of a few leading individual scientists alone, just as historians in the past generation attributed the social changes or the outcome of a war in a country to the individual monarchs or generals of the period

From this point of view a scientific contribution should be considered not as due to individual efforts but should be regarded as a production of socially collective efforts, just as a factory owner cannot claim his productions to be due to his handful of executive officers The difference existing between workers of different social strata producing goods in a factory or a scientific conclusion in a laboratory is devoid of any sharp line of demarcation And we are concerned here with the hired labour and common functioning behind production of commodities or experiments in the fundamentals of science It any distinction is to be made in the human relationship behind production, it will lead us to the conclusion of two categories of people, *viz* , labour power and owner of labour—*working-class* hiring out its labour and those who make profit at the cost of this class, or more simply, employees and employers If we clearly grasp this gross difference of human relationship behind production, the petty difference of white collars and no collars among the different strata of workers would vanish soon Differences among the various levels of workers are adjusted by the law of demand and supply A chartered accountant may be in great need today* but a large number of such qualified persons available tomorrow would lower their financial value and prestige attached alongwith Let us not forget that only a few years back when Kidderpore dock in Calcutta was bombed by the Japs the labourers there were paid @ Rs 3/- per hour which amount is seldom paid to the best scientific workers in India

With the advancement of science and industry and general education, standard of labour in all civilized countries has gradually improved Besides other factors, trade unionism has played an important

[1] Scientific Workers may be defined as the people who, by virtue of their special qualifications and/or experience in one or more scientific subjects, earn their living by hiring their skilled labour.

* During the war, retired financial officers of Government were in great demand amongst the war-rich to help them through the rigours of income tax laws The demand has somewhat abated now.

role in getting the voice of labour heard—voice against naked exploitation of the workers for the interest of the employees. In India the fate of the workers has been rather different. Foreign rulers came with the only idea of making the best out of the situation created by cheap labour, ample raw materials and vast field for selling the finished goods. Trade unionism prior to 1918 was considered something in the nature of sedition. It was only in 1926 that the Trade Union Act was passed and trade unions recognized by the Government. Since then, however, trade union movement in India has gradually taken a definite shape, though it is weak in comparison to the T. U. movement in Euro-American countries[2]. A great drawback in the T. U. movement in most of the countries, particularly in India, has been that it feels the difficulty of bringing all categories of workers in its folds. Differences in educational levels, pay and security of services, between the skilled and unskilled workers on one hand and technicians and scientific workers on the other led the people of the second group to consider themselves belonging to a different class from the ordinary workers, that is why they have kept more or less aloof from the main body of the working class. The result as it may be seen today is that those who are looked down as 'coollies' are in a much better position than their educated colleagues in hitting bargain and getting their grievances redressed, and this is so by virtue of the unity and solidarity being built amongst the working class. The fate of the scientific workers and technicians, although the standard of scientific achievement depends a great deal on their welfare, had already become precarious before World War II. During the war a vast number of technicians and other scientific workers have been trained and this number is out of proportion to the number of jobs available to them during the peace time. Condition of the scientific workers, thus, has deteriorated alarmingly. It may not be too much to say that the condition of the scientific workers is being neglected at the cost of the future progress of science. Perhaps a few instances would be more convincing.

Sugar factories in India employ on the average about five scientific workers in each factory as chemists, engineers etc. These factories are closed for approximately 6 months in a year (such factories are technically known as seasonal factories) and for this period the scientific workers are paid a paltry sum of Rs 40/- or 45/- as "retaining allowance", while, during the season seldom their salary rises above Rs. 100/- p.m. Textile mills, which are growing numerically every month, employ quite a number of chemists and dye technicians. In a very large number of cases, it is alleged, the scientific workers are paid according to queer systems. In one case, for instance, the scientific workers receive Rs 3/- p.m. as 'salary' and Rs 87/- as allowance! It is reported that such a 'system' saves the company from paying a large amount to the Government in the shape of taxes! The scientific workers, however, are expected to eke their existence out of this meagre salary while the sword of Damocles hangs over the tenure of their service.

Such docile persons as hospital compounders were exasperated to the extent of going to strike all over Bengal only a few months back. Among other grievances, that of inadequate pay was the most important one. We have every sympathy for such downtrodden workers and we congratulate them for their bold and united stand which has won them their demands.

The Government of Bengal during the epidemic period in 1944 had boasted of having opened 1,200 satellite medical relief centres for serving epidemic-ridden areas. But very few are aware that the 'doctors' at these centres were given an allowance of Rs 20/- p.m. It is no wonder that so many of them openly boasted of having sent their 'reports' without even going out of their houses.

That the chemists and pharmaceutists in the chemical industries are in no better condition has been amply proved by the stand taken by them along with their less fortunate colleagues, the common workers, during the wave of strikes all over India and specially in Bengal. Though prosperity of the chemical industries depends much on the efficiency of these scientific workers, average pay of a chemist is not more than Rs 100/- or 125/- p.m. This sum, if we remember the extent of inflation still prevalent in the country, has lost two-third of its buying power in comparison to the pre-war monitary value.

Conditions of research workers, teachers and professors in scientific subjects in our country has always remained far from enviable. More than once we have tried to bring to the notice of the people and the Government the conditions under which a scientist has to work in this country. Lack of assistants, proper equipments and paucity of funds sometimes stand as unsurmountable obstacles against the efforts of a scientist. Rs. 75/- p.m. is the maximum allowance offered to a research scholar in the Calcutta University where the atmosphere for research is said to be more congenial than in other universities. In several universities in India, we are

[2] Trade unionism in the Soviet countries is based on far advanced principles. Membership of a union is obligatory to every employee, each citizen there must take part in the life of the State and thus learn to control the State instead of remaining an onlooker. This process has been considered to be the best way for educating the people during the transitory period of the State entering from socialism to communism.

told, assistants for research work are paid @ Rs. 30/- p.m. Even in Calcutta University there are instances of research scholars receiving Rs 50/- p m and in at least one case we know of, a scholar with doctorate degree had to accept this term for the sake of love of his work! Even with this petty allowance a research scholar does not know if he will be given sufficient time to finish his work or if he would have to relinquish his post after the routine grant for two years

Last year a circular was issued under the direction of the Central Government that no scientific worker with M Sc. degree employed by the University should be payed less than Rs 200/- per month But such circulars are of no avail unless there be a machinery to see that the instructions are adhered to Lecturers and 'professors' in science in the mufussil colleges in Bengal have been known to accept posts carrying Rs 50/- p m

It has often been heard in some corners that there is no way out of such humiliating conditions unless India gains her freedom or unless the State intervenes With reference to the first assertion it may be said without hurting anybody's pride that our freedom from foreign domination would not *automatically* release us from all tribulations, it would only open the gateway for the removal of our hardships Great Britain, France or the United States are not dominated by foreign rulers, yet only after prolonged and tough fight the workers—scientific workers not excluded—have been able to have their lot changed for the better Nowhere outside Soviet Russia the State takes responsibility for the lives and functions of each of its citizens Asking the scientific workers in our country to wait till the State comes to their rescue means nothing more than to leave them to their fate If under the shackles of foreign Imperialism workers in India could move for getting their grievances redressed, as demonstrated by the workers' movement under the All India Trade Union Congress, if the combine of the vested interest of both white and brown varieties supported by the oppressive bureaucratic machinery had to give way, however little it may be, to the united demands of the helpless workers with no other weapon but their unions, it is disgraceful for the scientific workers not to take lesson from their own humble brethren and make efforts to save themselves After all, the State like God helps only those who help themselves.

It may be mentioned for the sake of information that in Great Britain there was started in 1918 an organization—Association of Scientific Workers when its membership was only 2,500. With the World War II, it became evident to the scientific workers in Britain that their salvation lay in their own strength. Today the "Association's membership of 16,000 includes scientific and technical staff in industry, Government service, the Universities and Agriculture, and their technical assistants Practically all of these members are employees Since the Association registered as a trade union in 1941 it has carried on hundreds of negotiations, both collective and on behalf of individuals, covering not only salaries but, also hours of work, holidays, sickness payment, service agreements, superannuation, compensation etc This work continues, with the immediate object of raising the salaries of all scientific staff above acceptable minima and conditions" Activities of the organization are not limited to a few demands of the scientific workers, it "has never paused in its efforts to improve the application of science for the benefit of society Its interests cover many fields—the education of scientists, how science should be applied to urgent problems facing the community (such as housing, health, food, fuel), how science should be organized and financed, publicity for science and the education of the public in the methods of science, etc" In short, the aims and objects of the Association are "for fuller use of science for national life—for education through meetings—and for action in public field" This organization during the last election in Great Britain has been able to send 14 members to the lower House so that voice of the Scientific Workers may be heard in the most powerful council house of the Nation and legislative measures be taken as demanded by the Association The organization has its own mouthpiece—"The Scientific Worker"

If the case of the British Association of Scientific Workers has been cited in details for an instance, it should be noted that such organizations have been started in other countries as well A conference of the representatives of the various national organizations of scientific workers was called in London on 20th and 21st July, 1946 for the inauguration of the World Federation of Scientific Workers. A provisional Executive Council was elected with Prof. F Joliot (France) as President Among the regional representatives in the Executive Council Prof M. N. Saha was elected to represent India On July 24th the first meeting of the Executive Council was held when outlines of the various activities of the Federation were discussed

It is high time that in our country too lead be taken to unite the scientific workers in one body specially organized for them Unless immediate efforts are made to improve the living conditions of such workers, unless their suggestions are incorporated for the betterment of national life, leaving the progress of the counntry in the hands of the legislators alone would hardly lift the country above the semi-feudal character as it is today.

ORGANIZATIONS OF SCIENTIFIC WORKERS

J D BERNAL

THE dawn of modern science in seventeenth century Europe marks at the same time the birth of organizations of scientists. The foundation of the Academy of the Lynx in Rome in 1601 was the prototype of all later scientific societies, and notably of the Royal Society of London (1663) and the Academie des Sciences (1666) in France. These early societies were concerned primarily with exchanging information on individual researches, with winning recognition for science and defending it against old prejudices of philosophers and clerics. They did not concern themselves with scientists for the simple reason that there was no such thing as a scientist in those days. A doctor, a lawyer, a landed gentleman, and rather more rarely a shopkeeper or mechanic, might occupy his spare time in scientific pursuits, but two hundred years had to pass before there was a real profession of science. Even in the nineteenth century, although a man might devote most of his time to science, he would most likely be professionally a university teacher, a civil servant or a company director The great expansion of science which has characterized the new industrial revolution did not occur until the present century.

The growth of the profession of science went hand in hand with the rapid development of industries based on scientific discoveries, such as the electrical and chemical industries It brought with it the creation of a new class of scientific workers, no longer independent gentlemen, but whole time employees of a company, government department, or occasionally beneficiaries of some educational trust This great growth of science, carrying with it a multiplication of workers, created new problems which the older scientific societies were unwilling, and constitutionally unable, to deal with They were traditionally and by composition concerned with the actual progress of science, and with the publication and discussion of results of scientific discovery They were not concerned with the use to which the scientific discoveries were put, or with the conditions of the research workers who made them The seniority and importance of their members, and their links with Government and industry, would in any case have made them unsuited for what was essentially a political and social task. The initiative could not, in fact, come from outside It had to come from the rank and file of scientific workers themselves.

The first step in this direction was a natural result of the increase in the use of science brought about by the first world war. In 1917, the National Union of Scientific Workers was founded, largely composed of university scientists and of newly recruited members of the recently formed Department of Scientific and Industrial Research. The Union, which later changed its name to the Association of Scientific Workers, has continued to this day. With the increasing use of science and multiplication of scientific workers, it has grown enormously in importance and maturity without losing its initial purpose and vitality. The objects of the Association of Scientific Workers, as stated in its policy, are "to work for the most effective use of science and scientific method for the welfare of society as a whole, and to improve the economic conditions of scientific workers These two aims are interdependent and cannot be pursued separately. The proper utilization of science can only be secured by a strong organization of scientists based on the protection of their professional status and economic interests. It is also essential to extend and improve scientific and technical education and the professional training of those seeking to become fully qualified scientific or technical workers"

The characteristics of the Association that distinguish it from other bodies are primarily that it represents all those who are mainly concerned with the day to day work of science, including engineers and technical assistants, and not only academic scientists Secondly it covers the whole range of the sciences and is not limited, like the institutes of physics, of chemistry and of various branches of engineering, to those particular sections of science and technics It even goes beyond the range of natural sciences and includes workers in the social sciences Thirdly, it envisages scientific workers as one section of the producing and working classes and not as some superior or managing class It is therefore a trade union, and as such is affiliated to the Trades Union Congress At the same time it recognizes that the position of the scientist, by virtue of his special knowledge, involves greater responsibilities, particularly the responsibility of popular education so that the possibilities of the use or abuse of science can be fully recognized. The Association has now some sixteen thousand members and one hundred and sixty seven branches, for the most part among scientists in industry, in universities and research institutes, and in the Government service.*

* The trade union interests of scientific Civil Servants are looked after by another organization which works in close relations to the Association of Scientific Workers—The Institution of Professional Civil Servants. The A Sc W. carries on the major part of work on the social relations of science.

The activities of the Association are, as may be imagined, very varied, but divided roughly into social and trade union aspects As a trade union, the Association aims at securing uniform and adequate conditions for scientific workers in every kind of employment, setting down salary scales and conditions of work and publication. It has negotiated several agreements on the basis of these scales with employers' organizations, and it also very naturally takes up the cases of individual members who have been unfairly treated. It maintains at the same time friendly relations with other trade unions, and acts through a Scientific Committee of the Trades Union Congress, as a general scientific adviser to all these organizations.

The social activity of the Association consists essentially of education and planning. A large number of lectures and meetings are held in the branches, and a particularly interesting feature is the fostering of the Scientific Film Society, both for the showing and the production of films of scientific interest The Association has also a number of committees which concern themselves with the detailed work of securing the proper application of science to various parts of the national economy They have, for instance, recently published a memorandum on the proposed central Government organization of science, and another on the use of science in the reconstruction of the coal industry, now nationalized, which may well serve to guide the direction of Government research

To implement these policies the Association seeks to influence trade unions and the legislature, the latter through its own M Ps and through an organization which came into being on its initiative, the Parliamentary and Scientific Committee Fifteen of the members of the Association are Members of Parliament. The Parliamentary and Scientific Committee is open to all M Ps. and to affiliated scientific bodies to the number of about sixty-five The Parliamentary and Scientific Committee consider all legislation in so far as scientific principles or practice are involved, or the conditions of scientists are affected. It also initiates discussion and the promotion of legislation for the better utilization of science It played a considerable part, for instance, in successfully urging the Government to increase the appropriations for scientific research and for university grants. The immediate policy of the Association is concerned with the most vital questions of the time, such as the use of atomic energy, the provision of housing and medical attention and the recovery of national industry. In general, the Association acts as a channel through which socially conscious and active scientists can carry out their responsibilities to society.

The British Association of Scientific Workers is no longer alone in this field of organization Already before the war there were Dominion Associations in Canada, Australia, New Zealand and South Africa, and a small but influential Association of Scientific Workers was set up in the United States Since then societies with analogous aims have been set up by many other countries, notably France, Czechoslovakia, Poland and China. These bodies, although they have the same general aims, naturally vary considerably in the scope of their activities, in accordance with the situation and state of development of science in their respective countries. The Association of Scientific Workers is in one respect unique, in that it is the only recognized trade union. But all have in common the same two major aims of securing better utilization of science for social welfare and assisting to maintain and improve the social and economic status of the individual scientific worker. The present situation of the world in the initial stages of recovery after a devastating war is one in which full utilization of science, and the prevention of its abuse, have become not merely desirable objects but essential conditions for the survival of civilization The responsibility of scientists for securing this is a special one. They alone have the full knowledge both of the possibilities and the dangers. Others cannot be blamed for acting blindly if the scientists have not made every possible effort to see that they are fully informed

The particular problems of great urgency will naturally vary from country to country, one kind of problem in advanced industrial countries, others in sparsely populated newly developed countries, and still others in old and populous civilization in a state of transition between medieval and modern life However, in every case there is a wide field for organized scientific activity. One of the lessons of the war was that science could be used not only for solving problems, but also in the first place, by the methods of survey, for finding out what the problems were and what was their relative importance and the prospects of successfully tackling them. Such information is absolutely necessary as a background for what is now being recognized as the strategy of scientific advance No longer, as in the nineteenth century, is it possible to leave the advance of science to the individual initiative of some hundreds of isolated workers each dependent on the benevolence of some institution or patron The planning of science has become a necessity ; but with it comes the danger of the imposition on science of rigid bureaucracy which more than in any other field of human activity would endanger its very existence. The solution of that problem is clearly to be found in the activity of the scientific workers themselves. Only by organizing a true democracy in the republic

of science can they secure the advantages of ordered progress while preserving individual liberty This is ultimately the most important function of new organizations of scientific workers

It would be superfluous to point out to the readers of SCIENCE AND CULTURE and to those interested in the formation of an Association for Scientific Workers in India, the objectives for the planning of science in India Indeed, we have found in the articles in the journal much guidance as to the way in which problems in our own countries can be attacked Nevertheless it would seem now more than ever opportune to secure the greatest support among scientists in India for the plans of utilization of Indian science for the benefit of the Indian people, and to get that support organized and active The more the scientists in the various countries realize their responsibilities and live up to them, the easier will be the task of scientists in other countries, that is why we in the Association of Scientific Workers in Great Britain would welcome the formation of an Indian Association of Scientific Workers

This appreciation would not be merely platonic In the last few months very definite moves have been made towards bringing together the various associations of scientific workers into a larger movement In July of this year a World Federation of Scientific Workers was initiated, and a provisional constitution was drawn up with the general object of uniting scientists throughout the world to work for "the fullest utilization of science in promoting the peace and welfare of mankind" Professor Joliot-Curie has been chosen as the first president, and a committee widely representative of scientists throughout the world, (including India in the person of Prof Saha) has been appointed The Federation will naturally work through its constituent bodies, but the advantages of a world organization will lie in the exchange of experience between members and the provision of a body of world scientific opinion that can envisage the problems of the world of today in a coherent and united manner

What those problems are is not difficult to see The two greatest and most immediate are the problem of providing food for the people of the world, and the problem of preventing a war which the development of science itself has made incompatible with the continuation of civilization After an initial emergency distribution of surplus food to needy areas, research and planning, and the exchange of information and techniques and production goods, could, if carried out fairly and energetically, solve the first problem in a few years The World Federation will act here to urge Governments and United Nations agencies such as F.A.O. to take on their responsibilities for world welfare. The organization with which the Federation is in closest and most friendly contact is naturally the United Nations Educational, Scientific and Cultural Organization (UNESCO) This body, which should be officially inaugurated in November of this year, is composed of the official representatives of governments charged with the promotion of science and the dissemination of culture Although its objectives in the field of science, such as the easier interchange of scientific workers and the reorganization of scientific communications are essentially the same, as those of the Federation, it has, as an official body, a fundamentally different function, that of giving effect to demands for which more active and unofficial bodies such as the Federation must strive to secure popular support

The problem of war is a far more difficult one, and brings the scientific workers directly face to face with political issues But these issues cannot be evaded Even in the United States a new and powerful body, the Federation of Atomic Scientists, has been most active not only in informing the public but also in lobbying the politicians to see that the great discovery of nuclear fission should be sanely used and shared with the world, rather than remain a permanent threatening and disturbing factor in world politics

By forming an Association of Scientific Workers of their own, and by joining in the wider efforts of the Federation, the scientists of India can make a notable contribution in securing the world from the dangers that threaten it as a legacy from a pre-scientific age

CHEMICAL ENGINEERING EDUCATION

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CHEMICAL Engineering has achieved considerable importance in India in very recent years Rapid development of chemical industry in India during the last 20 years and its immense potentialities in the very near future have given tremendous importance to chemical engineering study It has been established beyond doubt that for efficient design and running of chemical plants certain matters come up where the co-operation of chemist and engineer is a failure and which can only be solved by one brain—a chemical engineer trained in both chemistry and engineering It is the object of this paper to give a short review of the different aspects of chemical engineering

History

Although chemical industries like ceramic and glass existed thousands of years ago, chemical engineering is of recent origin and dates back from the end of the nineteenth century In the "Handbook of Chemical Engineering" by Davis (1901 edition) it is stated. "The public recognition of chemical engineer seems to have been made in 1880 in which year an attempt was made to found a 'Society of Chemical Engineers' in London It was soon found that the membership of such a society would be too limited in its numbers and the project, as it was then drafted, was abandoned The definition of the chemical engineer, as stated to this meeting, was that of a person possessing a knowledge of chemistry, physics and mechanics and who employed that knowledge for the utilisation of chemical reactions on the large scale."

In the year 1888 the first course in chemical engineering was started by the Massachusetts Institute of Technology with the following announcement: "The course is arranged to meet the need of students who desire a general training in mechanical engineering and at the same time devote a portion of their time to the study of the application of chemistry to the arts, especially to the engineering problems which relate to the use and manufacture of chemical products."

In 1904 Meade founded a monthly journal in U S A *The Chemical Engineer*, in which he wrote, "The chemical engineer is not a chemist who understands mechanical engineering nor a mechanical engineer who understands chemistry. He is primarily a chemist, a theoretical as well as a practical chemist, who knows how to carry out on a large scale the reactions worked out in the Laboratory"

The American people were becoming conscious of the utility of chemical engineering studies and the American Institute of Chemical Engineer was started in 1908

The development of Chemical Engineering in England did not take place till the end of the first world war when it was realized that the success of the German chemical industry was not due to their great chemical activity but to their trained chemical engineers The "Society of Chemical Industry" of Britain was existing since 1881 and under this Society the Chemical Engineering group was started in 1918 In 1922 the "Institute of Chemical Engineers" was established and the two mark the development of Chemical Engineering in Britain

Germany was one of the first countries in the world to recognize the importance of chemical engineering and the unit operations of chemical engineering called 'Process technique' were being taught about the end of the nineteenth century Three types of chemical engineering were tried in Germany

1 Education in Chemistry and Engineering subjects were equally stressed
2. Essential instruction in Engineering subjects with supplementary instruction in chemistry
3 Essential education in Chemistry with supplementary instruction in Engineering subjects

The first system has not proved very successful, the second produced good results, the third is still under investigation and sufficient experience has not yet been gained in order to pass final judgment on this system.

In Japan the chemical industry was greatly developed after the first world war There more stress is put on the technology of each individual industry than on chemical engineering in general

The first international chemical engineering congress was held under the auspices of the world power conference in London in 1936 in which 42 countries including India were represented This Conference marked official recognition of chemical engineering as a separate department of applied science in England

The second International Chemical Engineering Congress had been planned to be held in Berlin in 1940 but was dropped because of outbreak of war.

DEVELOPMENT

Chemical Engineering teaching started in England in 1911 but only after the first world war it was taken up in right earnest and the professional chairs were introduced at the Imperial College of Science and Technology and at London University. The first degree in Chemical Engineering was instituted in Glasgow University in 1924

In U S A the development of Chemical Engineering has been phenomenal and it can be said that Chemical Engineering, as it is today based on unit operations, first originated in America and there is no other country in the world where Chemical Engineering studies have been developed to such an extent as in America. The following table shows the number of students studying chemical engineering in U S A. in different years.

Year	Enrolment of students as undergraduates in Chemical Engineering course	Total enrolment of undergraduates in Engineering Colleges	Percentage of total in Chemical Engineering
1910	869	23,241	3 7
1921	7,054	56,766	12 4
1930	9,154	73,386	12 5
1935	10,780	64,137	16 8

This enrolment of 10,780 undergraduates in Chemical Engineering is higher than that in Civil Engineering, and is nearly as large as that in Electrical Engineering which is surpassed only by the Mechanical Engineering group This list does not include students studying other subjects allied to Chemical Engineering *viz*, Fuel Technology, Electro-technical Engineering, Petroleum and Ceramic Engineering etc.

WHAT IS CHEMICAL ENGINEERING?

A Chemical Engineer has been defined by the Institute of Chemical Engineers of Britain in 1923 as follows: "A Chemical Engineer is a professional man, experienced in the design, construction and operation of plant and works in which matter undergoes a change of state or composition "

The American Institute of Chemical Engineers in 1922 took the view—"Chemical Engineering as distinguished from the aggregate number of subjects comprised in courses of that name, is not a composite of Chemistry and Mechanical and Civil Engineering but is itself a branch of engineering, the basis of which is those unit operations, which in their proper sequence and co-ordination constitute a chemical process as conducted in the industrial scale".

CURRICULUM

There was a lot of controversy in the beginning about the curriculum to be followed in the course for Chemical Engineering It was also suggested that in view of the large number of subjects to be studied, the undergraduate course should cover a period of 5 or 6 years just like medical science. The American Institute of Chemical Engineers formed a Standing Committee in Chemical Engineering Education and this Committee held four conferences in 1922, 1926, 1929 and 1931 The first committee under the Chairmanship of Dr Arthur D Little in 1922 collected data from 78 Institutions in U S A, giving Chemical Engineering Education The following table shows the percentage distribution of time in a 4 year course,

PERCENTAGE DISTRIBUTION OF TIME

	Average of 65 schools	Recommended by the Committee in 1922	Recommended by the Committee in 1936
Cultural subjects	13 9	15	15
Mathematics	11 2	12	12
Physics ..	7 5	8	8
Mechanics .	5 3	6	6
Chemistry ..	30 0	28	25—30
Chemical Engineering	10 3	12	20—15
Other Engineering	16 0	14	12
Other Science .	2 1	2	2
Electric	3 7	3	—

The 1936 Committee insisted a thorough training in both science and engineering, chemical engineering laboratory work on a semi-plant scale, chemical engineering design, economics and unit operation This Committee omitted courses in Civil Engineering (except materials of construction), sanitary engineering, mining engineering (except geology), electrical engineering beyond its fundamentals and other specialized branches of technology This Committee recommended that "the Department of Chemical Engineering should be an independent department and not a subordinate section in the Department of Chemistry as is very often the case " This Committee further recommended for the case of science graduates as follows: "The chemical engineering curriculum outlined above is such that a student who takes a bachelor's degree in a course other than chemical engineering and who has included in his course adequate training in mathematics, chemistry and physics will be able to secure a bachelor's degree in chemical engineering after two additional years of specialized study."

The American Institute of Chemical Engineers recognized only those institutions which followed their curriculum and in 1936, 24 such institutes in U.S.A. were accredited.

In the Committees, apart from curriculum all problems connected with Chemical Engineering education *viz*, laboratory work, factory training, qualifications of teacher etc, were discussed Prof Walker thinks factory experience to be an essential qualification for a teacher The Engineers' Council for Professional Development (E C P D) was started in America in 1932 in order to give facilities to engineers in teaching line to be in close contact with industrial practice

Curriculum in England From information recently obtained from England, the Institute of Chemical Engineers of Great Britain propose a total of 4000 hours for a 4 year course and the approximate distribution of time is as follows

Chemistry—26%

Chemical Engineering (including unit operation, plant design, heat transmission, material of construction, transport and storage of materials, factory organization and management)—23%

Mathematics—10%

Physics—7 5%

Mechanics—3 5%

Engineering Drawing and Design—9 5%

Other engineering (including strength of material, fluid floor, heat engines, mechanism, electrical technology, physical metallurgy, fuels and combustion, power generation and distribution, surveying)—20 5%

Total—100%

Both the American and British Institutes of Chemical Engineers put great stress on works visit and workshop and factory training

Position in India

In India Chemical Engineering studies have been instituted at the Indian Institute of Science, Bangalore, at the Bombay, Benares, Mysore and Madras Universities and at the College of Engineering and Technology, Jadavpur (Bengal) There is no uniformity in the course of instructions given in these institutes and in view of the important part which Chemical Engineering is going to play in the development of chemical industry in India it is high time that a committee on Chemical Engineering education in India be formed This Committee should include representatives from the different educational institutions as well as from the leading industrialists and annual meetings of this Committee may be held along with the session of the Indian Science Congress Chemical Engineering curriculum is different in different countries according to the needs of the country Our curriculum should be based on the type of employment our chemical engineers are likely to get after graduation Prof W M Cumming in an illuminating article on the 'Proceedings of the Institute of Chemical Engineers' in 1938 strongly advocates inclusion of Chemical Engineering under the faculty of chemistry and writes "If the subject comes under the faculty of engineering, there is possible danger of the chemical side being neglected" This is all the more applicable to our country as our Chemical Engineers are most likely to be employed in Chemical Industries where good knowledge of chemistry is of primary importance and not in design offices, as machinery manufacturing factories are yet to be developed in India I hope the alumni of our country will think over the matter and bring the standard of Chemical Engineering education in India with other countries of the world

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REORGANIZATION OF SCIENCE TEACHING

RANG BAHADUR MATHUR

(Continued from the last issue)

METHOD OF TEACHING

There is considerable difference of opinion, almost confusion, about the choice of the best method to be employed in teaching science. The methods used, the important ones, may be listed as follows:—

1. Lecture.
2. Question and answer
3. Book
4. Assignment
5. Demonstration
6. Individual Laboratory
7. Problem
8. Heuristic
9. Historic

Each of them has its good points and defects. But perhaps any one of them is never used to the exclusion of all others, by any science teacher, rather are they used in various combinations. The lecture method is accompanied by demonstrations, or supplemented by pictures, charts, diagrams etc. The book recitation method uses pictures as illustrations in the text and is accompanied by laboratory work along with individual study by the student, and so on. All the teachers seem to employ different combinations of teaching methods.

But our considerations of the objects of science teaching show that many of the most important results are the products of the method employed rather than of the subject matter taught. For example, training in scientific method can only come as the result of the technique employed in getting at an understanding of scientific principles and their applications to life. It is at present assumed that science teachers perhaps do employ those methods which give the best results in science teaching. Observations will show that the case is otherwise. I suppose that unless a more uniform method of teaching is adopted, it is doubtful if we will be able to organize science teaching to yield the results, we hope to get from it. To find it out, is one of the unsolved problems in the teaching of science. A number of experimental studies were made in America to determine the relative merits of certain pairs of these methods when one of the pair is contrasted with the other.

'The data so far adduced' writes Downing, 'seems to warrant the conclusion that for students, either at high school or college level, who are taking their science as a part of general education, the demonstration method is as good under present conditions as the individual laboratory method and, considering the time and money saved, is the preferable method". This is in keeping with the general practice of teaching science in Great Britain, also in India, though of course it is done because it is convenient and not because educationally sound. But it does not prove that it is the best and the only method to be employed.

As it has been found that the better form of organizing science course is in units, it may be well to mention that the method which gives better result in teaching a unit is to follow these steps.

1. The unit may well be begun with a 'challenging introduction' something to command attention and interest immediately.

2. Exploration—asking preliminary questions to find if the pupils know what they will study in the unit, also to arouse interest and a curiosity to know answers to some of the questions asked.

3. Presentation of the new study material (Demonstration lecture—lesson)

4. Assimilation—in which the students study by themselves, being confronted with the problem for solution.

5. Assimilation test—to see if all have mastered the principle of the unit. This test should consist in large parts of problematic situations of the sort that arise in life that demand the application of the principles learned for their solution.

6. Recitation—to correct and elucidate minor difficulties that have become apparent from the teachers' study of the answers on the assimilation test or it may result in the students giving a summary of the unit.

An outline of the above scheme of procedure is given in the following table from which it can be seen that it is a combination of the good points of many of the teaching methods, mentioned above. The steps to be employed in the thinking process mentioned already will fall within steps 3 and 4, of presentation and assimilation, of the teaching method.

TESTS—LANGUAGE

A reorientation of outlook and a reorganization of science teaching will require great modifications in the methods of testing and examinations. For it is essential that we measure the results of the new teaching to find out how successful we are in

achieving what we set out to accomplish The present system of examinations is by no means reliable and satisfactory

Newer science tests will have to be formulated and standardized, or else adopted and modified They afford a great variety of types, completion, best answer, multiple choice, matching, true false etc — a much larger assortment than the teacher uses today Such tests are objective, can be marked the same by any number of teachers, the answers to the questions are brief, and quickly answered by the students They can cover a great amount of subject matter, and thus test a wide range of knowledge Thus they are fairer to the students than the present essay type of tests. They can also be easily marked by a teacher This will not mean the abandonment of the present essay type of test altogether, for it has its own value too, of giving opportunity to the student to organize his knowledge on a topic and present it properly But we must have other types of tests also to test facts, attitudes, important ideas, and ability to do reflective thinking

their environment, the natural phenomena around them, and to use the knowledge so gained in their daily lives, also to establish in them some good habits of health and hygiene, the important thing is to keep alive their interests, attention, activities, and sense of curiosity about things, natural and physical.

According to educational psychology school children are divided into three groups The first group includes pupils up to the age of 10 or 11 This is the primary stage The second group includes pupils upto the age of 13 or 14 This is the middle stage The last group includes pupils above the age of 14 or 15 This is the high stage

Before the age of 10 or 11, *i e*, in the primary classes, children have nature study, observing nature in all its phases, and dealing with common objects and phenomena Beyond the age of 14, a student is in the high classes, when he can grasp or understand abstract ideas, like the laws and principles of science, its symbols and formulae We have discussed science teaching at this stage The age group 10 or 11 to 13 or 14 of the children is some-

SCHEME OF TEACHING METHOD

Steps in learning process	Steps in the class room method	Student activities involved	Testing results
Stimulus or motivation on seeing the problem	Challenging introduction by the teacher—Sketch of the unit, Exploration, Review previous work, Recall experience pertinent to unit	Listening, observing, note-taking or reading preview in unit Discussion and written test	Written or oral composition on preview Questions and exercises
Study (directed or thinking or solving the problem)	Presentation, Assimilation, Individual or Class study	Reading—Extensive and Intensive, Experimentation, Drawing, Observation of demonstrations, Demonstration before class, Responses to exercises	Oral and written questions Composition, True-false-tests, completion tests Best answer, summaries Writing out experiments Discussions in class Self testing exercises
Reaction or application or use of knowledge	Assimilation test Recitation	Preparation of outline or summary, Oral and written recitation	(The activity is itself the test)

So much has been said and written about the language in which education should be imparted to our children. I can add nothing to that Science is taught in the Indian languages up to the 8th class, I wish it were so up to the 10th Teaching science on the newer lines, when it is organized in units, will bear wonderful fruits, if it could be so.

SPONTANEOUS SCIENCE OF CHILDREN

We have so far considered the curriculum, its organization, and its method of teaching with respect to the high classes *i e*, 9th and 10th classes Let us now study the science of the junior classes Here we do not expect to develop much of scientific thinking Though we do want the children to understand

what different in its psychological characteristics from the other two At this stage the children start reacting to their environment, but understand and are interested in only concrete and real to life science

It is found that children undergo a sort of a mental change, more or less, at about the age of 10 or 11 Some progressive schools take this into account and build up studies and activities for them accordingly. In my experience of teaching nature study to 5th and 6th classes, for a number of years, I have been able to verify it myself I find that there is a psychological change in my children during the classes 5th to 6th While they do not ask many questions when they are in the 5th, they seem to burst out with them when they are in the 6th I

have been able to collect about 500 of these questions Some of the important questions asked *i e*, those which occur frequently and are asked by many children, nearly every year are given below

A Who is God? What is God? Who made God? How was He made? Where is God? How do we know there is God? Why can't we see Him?

B How were the sun, moon and the earth made? What are the sun, moon and stars? Why is the sun so hot? Where does it get its light from? How far is the sun from the earth?

C Where is the beginning or end of the earth? Why does the earth go round the sun, and not the sun round the earth? Why is the earth round? How did it become so?

D Who was the first man on the earth? How are we made? How are the trees made? Who came first—the hen or the egg?

E What is the sky? Why is the sea salty? Why do we breathe air? Why is fire hot? How is the air made? How is the water made?

F Why does not our earth fall down? Why do the stars fall? Why don't we fall off the earth?

G Why do we see by the eye and not by the hand? How have we learnt to talk, write, and read? How do our hairs grow?

H. How do we find out from the thermometer that we are sick? How does the aeroplane fly? How is the voice carried by the radio? How does it work? How is the cinema made? How is electricity made? How do we talk by means of a telephone?

These questions give an insight into the mind of the child, as to what he observes and sees, and thinks about them They give a clue to his scientific interests They are quite wide in their range Naturally No part of the environment is devoid of scientific interest to children, questions are asked about everything A science course built round these questions asked by children is called 'spontaneous science' by A G Hughes This 'spontaneous science' should properly form the basis of the study of science in the middle classes *i.e*, for children between the ages 10 or 11 to 13 or 14 It will have real living interest for the children, and will be undifferentiated *i e*, divided into different branches of science.

It will be a worthwhile task for the science teachers to ask and collect such questions from their children, to analyse them, and find out their scientific interests. If ample data of this sort is gathered, we will then know what to teach them at the middle school stage.

'Common Science' by Washburne, is an excellent and the only book I know of, which has been written round the 'spontaneous science of children' I recommend it, with its companion volume, 'The Story of the Earth and Sky' to all science teachers in the middle classes, as models on which to base their own teaching and curriculum In the preface to 'Common Science' Washburne writes "A collection of about 2000 questions asked by the children forms the foundation on which this book is built. Rather than decide . . . what is it that children ought to know, or what knowledge could best be fitted into some educational theory, an attempt was made to find out what children want to know The obvious way to discover this was to let them ask questions The questions gave a very fair indication of the parts of science in which children are most interested Physics, in simple, quantitative form, not mathematical physics, of course,—comes first, astronomy next; chemistry, geology, and certain forms of physical geography (weather, volcanoes, earthquakes etc.) come third, biology, with physiology and hygiene, is a close fourth; and nature study, in the ordinary school sense of the term, comes in hardly at all."

Scientific interests of Indian children may vary from those of other countries; they might even vary from one region to another But such a survey will give us the basic or common interests of children at this age level, which may be incorporated in their course in science

Scientific interests of Indian children may vary from those of other countries, they might even vary from one region to another But such a survey will give us the basic or common interests of children at this age level, which may be incorporated in their course in science

Conclusion

These discussions might have shown somewhat how far removed from the science we should teach is the science we do teach our children If we want to make it worthwhile for our children to study, we should apply science to science teaching to improve it Though it is not possible nor desirable that we borrow entirely the system of scientific education of any country, may be England, America, or Russia, it is not practicable either to apply heuristic method to discover for ourselves what we should teach, and how to do it, now The better method would be to select the system or part of systems which seem to be based on the right lines of education, borrow them, modify them according to our circumstances, experiment with them, and if they stand the test satisfactorily to adopt them for our own use The emphasis is an experimentation, of applying scientific methods to improve science teaching. Some of our training colleges have opened post graduate classes,

and it is hoped others would follow It will be the task of these colleges, and their graduates to do this work, to examine the entire system of education for its defects, loopholes and their causes, and their after experimentations to find out which would be the best remedy to eradicate the evils Only thus can our education can be put on the right lines. For, in the educational sphere, as in others, the country and the people are eager to make a move, and it is essential that when we do, we move in the right direction

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THE FAMILY LIFE OF THE SANTALS

(MISS) UMA CHOWDHURY

FOR the past few years, I had to spend a few months every year in the town of Giridih in the Hazaribagh district This gave me a good opportunity to come into close contact with the Santals living there Realizing that it would be a task of great psychological value to compare their religious beliefs and ideas with those of the educated community which I had already collected, I decided to work amongst them The psychological study of the religion of a community, however, necessarily involves close observation not only of the behaviour of the individuals constituting that community, but also their social behaviour as manifested in their customary acts and ceremonials, in their family life, and in other forms of group life. Hence I had to undertake a detailed study of the family life of the Santals A large number of families spread over a few villages within a radius of about ten miles from Giridih were investigated

In addition to the difficulties generally experienced by investigators in such a study, I had to contend here with two special ones. The first arose out of the vast gulf that exists between them and us in almost every aspect of life—the social distance as it is usually called , and the second was the language difficulty. The last one was comparatively easier to get over. With the help of books and constant contact with the people, I learnt the Santali language It may be mentioned in this connection that the Santals are very proud of their own language and do not believe that any one besides themselves can learn their language properly. The first difficulty was heightened by the fact that the Santals are generally indifferent to strangers and are unwilling to extend any kind of hospitality or co-operation unless the strangers are introduced to them by one of their own tribesmen Once this introduction is made they become very hospitable and answer all questions unreservedly I was fortunate in establishing proper rapport with them and was thus not only able to get information which I needed, but became the recipient of personal confidences of many. It was because I could speak to them in their own language and was introduced to them by some old and influential Manjhi that I succeeded in doing so

Primarily the method adopted was the same questionnaire method that was used in my previous work referred to above. Some of the questions were remodelled to suit the present environment I supplemented that method, however, in other ways. In addition to taking detailed notes and collecting different types of songs, I attended some of their festivals also and had photographs taken of these and of different types of their dances I gathered necessary information also from some wise old men of the villages who are called 'Gorombaba' or Grandfather The 'Gorombabas', however, hesitated to dwell on such questions as courtship, love, marriage, pre-

nuptial and post-nuptial, sexual relationships etc For information regarding these, I had to depend on the 'Goromayo' or Grandmother or some old women who are village Grandmothers by courtesy as also on the sister-in-law of the lovers, because in these matters they keep the full confidence of the young lovers They discuss such topics very freely amongst themselves and reflected the same free spirit when talking to me Some girls in a friendly mood gave me detailed accounts of their love-makings

The Santal family is patronymic The head of the family is the eldest male who is also the chief property holder Women do all household works and also participate in agricultural work Generally the Santals live in single families, joint families being rare amongst them Occasionally there are some dependents who have to contribute something to the family fund from their daily wages Able bodied men, absolutely dependent on others are seldom met with in the Santal community Thus the average family is constituted of the (*i*) father—who is the head, (*ii*) mother, and (*iii*) dependent children Many keep domesticated animals, *e g* , cows, buffaloes, pigs, hens.

The food habits of the Santals studied by me correspond largely with those described by Rev P O Bodding [2] It may be said that the Santals take four meals a day , two principal ones, one in the mid-day and one in the evening which consist of 'Daka and Utu', and two considerably lighter ones, one in the morning when they take rice soaked in water and another in the afternoon consisting of 'Chhatu'. 'Daka' (cooked rice) is their principal food. The Santal 'Utu' (Curry) may be prepared from pulse, meat, vegetables etc , with the help either of mustard, Surguja and Mahua oils 'Utu', however, may be described as a luxury, for the majority of the Santals are extremely poor and they have to depend mainly on salt, chilly and 'Daka' (cooked rice) or Dak-mandi (rice-gruel) or Chatni or any type of boiled leaves which they secure in large quantity from fields or jungle At times of scarcity, they usually take Bajra or Joar, gruel instead of Daka Although they keep cows, most of these cows are unfortunately dry and only a small quantity of milk can be secured for the children They do not take fish or meat in their daily meal, not because they are vegetarians, but because they cannot afford to do so At times of festivals, fowls, pigs, goats, and occasionally doves are slaughtered and their meat eaten Sometimes, they delight in taking roasted Dhaman snake and uncooked red ant In their stories and religious accounts, we find references to cows and buffaloes being sacrificed to their 'Bongas',* but I have not witnessed any such sacrifice during my two years' stay and work with them

* 'Bonga'—Gods, good spirits, evil spirits

They smoke *bidis* Most of them carry tobacco dust and lime which they mix and take at frequent intervals As regards drink, formerly they used to drink their own type of Handi which they prepared from Mahua or rice and which they also used as medicine These drinks are now strictly banned by Government They are thus forced to drink wines which are sent to the Santali villages through excise shops and sold at very high price Generally it is the men who drink But at the time of festivals both men and women of the whole village drink abundantly and sing and dance together for days and nights It is one of the gravest misconceptions, however, to hold that the Santals spend all that they earn on drink. As they do not consider drinking to be a sin, they drink whenever they get any opportunity of doing so, but my close observation has revealed that they are very mindful of their domestic duties and do not spend all they earn on drinking

Ceremonies and festivals that are prevalent in Santal families are mainly of two types

(1) Some festivals are celebrated in connection with the natural processes of life, *e g* , birth, marriage and death

(2) Some are celebrated as seasonal festivals (Sohrae) during the month of Paus just after the crop-cutting and Baha (festival of spring) etc

In all these festivals, they drink excessively and sacrifice pigs, fowls, goats, to their 'Bongas' These ceremonies have a religious background Santal tradition looks to the 'Maran Bonga' (greatest Bonga) as the greatest power ruling all other 'Bongas' and in all the social ceremonies and religious festivals they worship that power with their first offering and sacrifices A parallel to this hierarchy is found in their social life—the place and honour that is attributed to the village headmen The village headman is the leader of the village and is considered to be its sole authority The villagers are found to obey him in all their daily, personal, and social activities During all religious festivals, every Santal family after propitiating all the outside 'Boṅgas' like 'Maraṅ Boṅga' and his companions offers worship to their 'inside' Boṅgas These 'inside' Boṅgas are nothing but the departed spirits of the Santal adults who find their abode in mountains, rivers and jungles But the 'Maraṅ Boṅga' has supreme authority over them all and without the command of 'Maraṅ Boṅga', they cannot do anything Santals believe that 'Maraṅ Boṅga' is invested with all powers and if they fail to propitiate him, their whole community would be in danger. Similarly they believe that their family 'Boṅgas' are invested with some power and if they are displeased with their descendents, they may punish the latter with all sorts of evils (disease and death). The belief is current still and even now they attribute all suffer-

ings, diseases, and premature deaths to evil intentions of the departed spirits. So whenever any mishap occurs in the family, they become very much concerned about propitiating these 'Bongas' by offering worship to them.

The Santals live in mud houses which they build for themselves. Almost all of them now use small tiles for their roofs. The original thatched roofs have become rare. Generally all the houses contain two courtyards—one outer and one inner. While the outer one is used mainly for preparing and cleansing agricultural products, the inner one is utilized for many purposes. During summer the Santals usually sleep here for their rooms become very stuffy. The rooms have no windows, but only a few small holes which serve the purpose of ventilators. In winter, they sit here round the fire place and generally the head of the family narrates some of their interesting traditional folk-lore to the children. Generally every family can afford one habitable bed room and one ante-room which they use both for the purpose of kitchen and thrashing corns. For want of space, the unmarried young adults have to sleep in the same room with their parents. But the Santals build separate rooms for their married sons. Beside the rooms and the courtyards, they have two sheds for their domestic cows, buffaloes, goats etc., and one sty for the pigs. One remarkable characteristic of the Santals is that they are very particular to keep their houses and things clean. Santal wives are particularly responsible for keeping their houses clean.

Every Santal home has a flat square place for the 'Bhiṭar' or 'inside' Boṅgas. These places are prepared with mud and are considered sacred places for offering worship to their 'inside' Boṅgas. In every Santal village, there is a sacred 'Mājhithān' for offering worships to the departed spirits of the village headman. In the Hazaribugh district, there is a class of people called Chethier who get signs and symbols of particular stones or woods in dreams and these are represented in the Mājhithān.

No Santal man or woman remains unmarried throughout their life. As soon as they attain maturity, either they marry the person of their own love and choice or they depend upon their parents or village headman for securing suitable partners for them. Even men and women of the sexually frigid type enter into matrimony and try to get cured of their frigidity by some medicine or by seeking the favour of the ancestral spirits. The religious idea behind it is that if they die without any issue, their family would be extinct, consequently their ancestral spirits would no longer get any propitiation and they will then be cursed by the spirits and meet with all sorts of evil. Of the ten different sects (*i*) Tudu, (*ii*) Kisku, (*iii*) Hembram, (*iv*) Hasda, (*v*) Murmu, (*vi*) Soren, (*vii*) Baske, (*viii*) Besra, (*ix*) Chorĕ, and (*x*) Marndi, the first seven are considered to be the sons and daughters of Pilchu-Haṛam and Pilchu-Buḍi* and other three Chore, Basra, and Marndi are descendents of Hāwa, Udamhāwa, Thākur-jiu respectively.

Broadly speaking, there are two main forms of marriage—(1) Raeber Bapla or marriage that is arranged by the go-between, and (2) the forms of marriage where the couple choose their own partners. Although the first form of marriage is more prevalent among them, various types of love marriages occur frequently. Divorce is a sanctioned custom of the Santals.

Most of these Santals buy their cloth from ration shop. Only a few family have got some *charka* and hand loom. They often prepare their own cloth. Men usually wear *Kupni* or *Bhagwa* (small strip of cloth) and sometimes, they wear *dhoties*. Women wear *saries* without border and I did not find them using any blouses. In such family, yearly they use two pieces of cloth per head. They have to observe social obligations. It is considered to be a part of their duty to invite their relatives during the religious and marriage festivals and *sradh* ceremonies. Some of them presents *saries* to their married daughters at the time of festivals.

Hunting is not now considered as a necessary activity of their life. But still they are very much enthusiastic about it and at least once in the year, they must go out for hunting in some dense forest where they use their original type of weapons.

It is rather disheartening to describe the economic life of the average Santal family. Like the peasant community of Bengal, the majority of the Santals are extremely poor and live in perpetual indebtedness. Agriculture on which they mainly depend for their food does not provide them even with their minimum requirements. They are, therefore, driven to seek work in collieries, or mica factories or to work as field labourers for others. Here again, the wages they earn are hopelessly inadequate to meet their necessities, not to speak of paying taxes and rents. Hence restricted diet and chronic indebtedness seem destined to be their inevitable lot. They borrow money from money lenders from Kabul, *Mahajans*, and others on such terms and conditions as to keep them perpetually indebted to the lenders and bound to them for life-long service. Male adults, young and unmarried women and widows go out for work in fields, factories and collieries, but it is not customary for the wife of any able bodied person to do so. They may work in the field with their husbands in the crop-cutting season, but their main work is to manage all

* Pilchu-Haṛam and Pilchu-Buḍhi. According to Santal tradition the first man and the first woman were Pilchu-Haṛam and Pilchu-Buḍhi respectively.

household affairs Sometimes when very hard pressed, these wives also work in the fields of their neighbours in exchange for 4 seers of paddy and two meals per day and earn money by splitting mica at home Besides that, they prepare broom-sticks, leaf-cups, and ropes for the Sunday market and for the purpose of their personal use.

Although the economic condition of the Santals is very much depressing and they have to live on restricted diets, the condition of their health is generally good. The physically defective children, such as deaf, dumb and other types of physical defectives are usually met with more frequently in the colliery areas than in any other Santal villages As regards mental defectives, I may mention that I found only a few hysterics among these hundred families These hysterics are described as being possessed by 'Bongas' So by means of their traditional customs and rites, they try to drive away these 'Boñgas' I have not yet met with any insane person among them

Child mortality is considerably high among them But it is curious that even the parents of the dead children do not attach much importance to the death of their children. They are rather indifferent and often fail to recollect the exact number of their dead children It is customary amongst the Santals to sacrifice a fowl in all their festivals to each of the dead adult members of their family and they make it a point to remember them But they do not believe that the dead infants may assume the form of 'Boñga' So no sacrifice is offered to them.

It is interesting to note that though the Santals studied here live in such close proximity to the sophisticated atmosphere of civilization and have constantly to come into contact with it, they still venerate their own customs and traditions One reason for this is that they believe themselves to be the oldest people on earth descended from Pilchu-Haṛam and and Pilchu-Buḍhi Those who have heard about the story of Adam and Eve consider it to be merely an imitation of their own age-old lore of creation

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SCIENCE AND MANKIND

" . . If you mean by science a way of thinking, then, indeed, the world needs more science The world needs more scientific thinking—more widespread scientific thought among men in every field of human endeavour Honest, factual thinking

"Upon there being a scientific approach to human problems depends the future of man Without the technique and the scientific method, without its matter-of-factness, we shall be fogged by ignorance, by dogmas and by our emotions, and the world will never be rid of its explosive cross purposes and muddle-headed wrangling

" . it was a revelation to me to see the extent to which science had been mobilised by the Government (of Britain) for the achievement of victory. I will not say that it was perfectly done, but it was more nearly perfectly done than it had ever been in the past We must not lose the lessons of that experience , we must apply them to the causes of peace and of social and economic advancement.

"We have also learned not only that problems can be solved extraordinarily quickly when we give scientists a free hand and enough money, but that we can apply with great success the scientific methods to problems right outside the laboratory

"We must keep science free and unchained, give it wide scope for initiative, and to pursue knowledge for its own sake , but we need, over the whole field of science, a combination of freedom, initiative, and social science

"If we profit by our experience, there are great hopes for the post-war world, and with the help of scientists we can bring richness and peace to our lives as never before. For the first need of the world is to realise that it is a world, one world, as Wendell Wilkie said, in which we all live. And the work of science is to show us how to make the earth possible to live on and to help us live on it abundantly and peacefully "

—Extract of a speech by Herbert Morrison, Lord President of the Council, before the A Sc. W Conference on "Science and Human Welfare"

Notes and News

CIVILIZATION AND THE PURSUIT OF KNOWLEDGE

THE caption of the present note formed the subject of an illuminating presidential address by Sir Richard Gregory, BT, F R S, on the occasion of the annual meeting of the British Association for the Advancement of Science, held on July 20, 1946 After about seven years of forced inactivity due to the emergent conditions of the war, this is the first annual meeting of the Association since they met at Dundee in 1939, and no other subject would have been a happier selection than the one chosen for his address this year Sir Richard traced the growth of civilization from the first appearance of man on this planet, dwelt at length on its meaning and interpretation, the development of natural knowledge and philosophy, the impact of science and invention on human society and institutions, the influence of language, and on such subtle questions as civilization and ethics

The appearance of the *Homo sapiens* as a product of evolution is of a very recent date—at any rate it could not have occurred earlier than 100,000 years—compared to the span of existence of organic life on the earth, which is known to be about 1,200 million years Sir Richard quotes a very impressive analogy, due to Prof James Ritchie, the Zoologist, to illustrate how short the period of human tenancy has been in the entire period of existence of organic life He says

"Taking the twelve hours on the dial of a clock to represent the span of 1,200 million years, early forms of life would cover the period from midnight to seven o'clock From this hour until 11 15, fishes and amphibia, reptiles, birds and mammals would successively develop and predominate, with primitive man making his appearance at less than a minute before noon, and our own species less than a second and a half ago On this time-scale, the period from our Neolithic ancestors of about ten thousand years ago to the present epoch is represented by about one-third of a second "

Speaking of the meaning of civilization he remarks:

"Its roots (namely, of civilization) are in the human mind and its character is determined by the aptitude to accept ideas and give effects to them The courses of development of material resources, of morals and religion, of language and other means of emotional expression differ in time and place, but the creative or receptive agent is always the human mind. When given opportunities for development, coloured people have proved themselves just as capable of creative thought and efficient action as the white or other groups

It is indeed unwarrantable to assume that any group of individuals or racial types are superior to others solely because they possess greater wealth or power There are many types of civilization but none provides standards of highest attainment in every field of human thought and endeavour In the past, each has had its rise and fall, sometimes because of climatic or other natural changes, but more often through the use of superior military forces and the subsequent occupation and administration of the vanquished territory They all belong to the panorama of structures of human societies and take their separate places in the continuous record of the world's history, beginning with the advent of the New Stone Age about ten thousand years ago "

Speaking of the early philosophy which originated with the Indus Valley civilization of the Aryans, Sir Richard Gregory says

"In this early philosophy, man is the centre of the cosmic scheme and he shares the vital force with the gods, without being dependent upon them, though they possess it supremely He differs from all other things, animate or inanimate, in the capacity for thinking, leading eventually to the Brahmans becoming the 'head' of the social organism because they possessed it to a higher degree than other classes, including the warriors, whose powers depended upon the use of 'lower' parts of the human body Brahmanism became a new Hinduism with the teaching that every Hindu could share this knowledge and by mystical thought attain to the same perfection. Many variations of these beliefs have been formulated and incorporated in Hinduism, but the main ideas remain the same With the introduction of Buddhism in the sixth century B C, came the teaching that the performance of sacrifices and daily rites to deities were no measure of attainment of the right way of human life and conduct Since that time Hinduism and Buddhism, together and separately, have determined the course of civilization in the Middle and Far East.

"It is a remarkable historical fact that the sixth century B C. was a period of great emotional and intellectual ferment, in which there was displayed a general and widespread interest in religious and philosophic speculation, particularly in the East Buddhism, Taoism, and Confucianism, all had their

origin in that century, and their followers to-day number more than half of the population of the world There is no personal god in these religions or ethical systems, but conceptions of relationships between the heavens and the earth, or the universe and man, are common components of them Each is concerned with a way of life and the exercise of human virtues, and each is tolerant of the others It is thus possible for the three cults, with Christianity in addition, to be accepted together as guides to individual conduct, without discrimination between them "

The concluding remarks of his presidential address referred to progressive humanism "Faith in this spirit", he said, "in whatever way it is promoted or manifested in the works of man, is often regarded as presumptuous pride in his creative and constructive capacities and therefore irreligious in the sacred meaning of the word The spirit is, however, associated with all aspects of intellectual and material progress which have influenced the course of civilization "

"Humanism in this sense is the integration of all influences which promote the development of the human race, whether or no it includes the teaching of a particular religion Principles or practices which raise man out of his animal ancestry and add to his status among living creatures can rightly be termed humanistic Their spirit is displayed in works of science as well as in art and literature, and the measure of their value is that of the opportunities these afford for improving human welfare on the highest standards that the mind can conceive and the heart will sanction

"Whatever convictions are held about the meaning and purpose of man's existence, he finds himself on a globe from which he has to obtain needs of life, and also with a mind which can appreciate such abstract qualities as beauty and love, goodness, justice end mercy, whether seen on the earth or projected on the heavens Modern humanism takes account of all these factors of cultural development, secular or sacred It understands very clearly that the earth is but a temporary home not only for the short span of individual life but also for the whole human race As tenants or trustees our duty is to make the best use of the resources of our heritage by the exercise of all our talents and with the belief and hope that by so doing we are contributing to make men god-like if not godly in the sense of religious faith So may the earth become part of the heavens of the universe in spirit, as it is in truth."

WORLD FEDERATION OF SCIENTIFIC WORKERS

The formation of a World Federation of Scientific Workers was announced at a conference, held in London on July 20 and 21, 1946, of representatives from the American, Australian, British, Canadian, Chinese, French and South African Associations of Scientific Workers and from the similar recognized associations of research workers, engineers, architects, and teachers of many lands, and also of observers from Belgium, Czechoslovakia, Denmark, India, Italy, Norway and Republican Spain

Recently, there has been some discussion on the advisability of forming a world-wide federation of all the national organizations of scientific workers interested in the social relations of science and the problems of economic security On the occasion of the 220th anniversary of the U S S R Academy of Sciences, when scientists from many lands assembled in Moscow and Leningrad, the question was discussed informally among British, French and Russian scientific workers, and there was general agreement as to the advisability of such a move A further discussion on the subject took place at the conference on "Science and the Welfare of Mankind", held in London in February 1946, under the auspices of the British Association of Scientific Workers, and it was decided to prepare a draft constitution and circulate it to all interested organizations and persons The July 1946 conference met to discuss the draft constitution and inaugurate the formation of the World Federation of Scientific Workers

The conference was opened by Prof P M S Blackett, President, and Dr W A Wooster, Honorary General Secretary of the British A Sc W The draft constitution with numerous amendments from various organizations was discussed and the general principle approved, but it was decided that the future Executive Council would draft the detailed wording of the final constitution It was, however, given out that the fundamental aim of the Federation will be 'to work for the fullest utilization of science in promoting peace and the welfare of mankind' and that this will be achieved through a wide range of activities, including action of immediate world problems concerning science, the improvement of science teaching, encouragement of international exchanges of scientific personnel, information, and apparatus, the improvement of the social, economic, and professional status of scientific workers, and the encouragement of scientific workers to take more interest in public affairs and the urgent social problems of the time

The conference ended with a discussion opened by Prof J D Bernal on the immediate work of the Federation. Suggestions made were:

(*a*) Mutual assistance to strengthen existing organizations and to initiate new ones where not yet set up

(*b*) Formulation of policy on the control and utilization of atomic energy, world food shortage, and the recovery of science in war-devastated countries

(*c*) Consideration of a code of rights and duties for scientists.

(*d*) Efforts to improve training facilities for science students and technicians and the teaching of science in schools

(*e*) Investigation of secrecy and commercial utilization of science.

(*f*) Closer integration of the individual sciences

(*g*) Science propaganda, by films, books and broadcasts

It was agreed that the Executive Council should collect, collate and recirculate suggestions for work, and mechanisms for carrying them out

The following provisional Executive Council was elected

President Prof F Joliot (France), *Vice-Presidents* Prof J D Bernal (Gt Britain), Prof. Semenov* (U S S R), *Regional Representatives* Czechoslovakia and Poland, Prof M A Belehradek*, British Commonwealth, Mr N. Veall, W Europe, Prof L Rosenfeld, Far East, Dr TiU Chang-Wang*, India, Prof M N Saha, U S A. & South America, Dr P M Doty

The asterisk indicates that consent of this individual has to be obtained

Two further regional representatives remain to be elected, to represent the Soviet Union and Scandinavia

It was further agreed that each organization at the conference should elect a corresponding member to receive all information from the Executive Council

It was agreed that at present the Office of the Federation should be in London At a later date, as a result of a very generous offer by Dr Needham of office accomodation and secretarial assistance in the UNESCO headquarters in Paris, it is hoped to be able to move to Paris some time before the end of this year

MAGNETIC AIR-BORNE DETECTOR

MAGNETIC air-borne detectors, developed during the war as a highly reliable device for detecting enemy submarines too deeply submerged for ordinary aerial observation, are now reported (*Bell Laboratories Record*, Vol XXIV, No 7) to have received successful application in prospecting for potential oil and mineral producing areas. The device principally consists in carrying highly sensitive magnetometers on the wing of an airplane or in convenient part such as 'the forward part of the belly of a blimp' The needle reacts to the presence of the magnetic metal in a submarine below or an ore body buried under the surface of the earth.

The success of the device in locating submarines at once indicated its peace time geophysical application, and its importance as a means for a quick large scale survey of geological structure has already been demonstrated Successful airborne magnetic surveys have been carried out in Iron County, Michigan, and in the Adirondacks, in a search for iron ore deposits for use in war Later, the method has also been applied in conducting reconnaissance surveys on areas suspected to be associated with oil An area of about 40,000 square miles, in the U S A and Alaska, has already been mapped The U S Geological Survey and the U S Coast and Geodetic Survey have undertaken to conduct such surveys on a large scale in future and expressed the hope that the method will make possible 'the first really accurate magnetic map of the world'

The air-borne magnetic detectors, naturally enough, make possible a continuous record of the magnetic variations of the terrain over which the plane is flown, which is a distinct advantage over ground surveys Further, the aerial method is reported to give more accurate appraisal of the geological structure of an area than is possible by the usual magnetometric surveys conducted from the ground Extreme care is taken in using only brand-new, non-magnetic tools, and often the workers are required to use special clothing and shoes in order to allow the delicate needles to respond only to the variation due to sub-surface characteristics

The new device which bids fair to be a very important geophysical tool in future, is the result of joint investigations carried on by the researchers of the Bell Telephone Laboratories, Naval Ordnance Laboratory, the Gulf Research and Development Company, and the Air-borne Instruments Laboratory of the Columbia University Division of War Research.

Recently it is reported in the daily press that, as a result of such aerial magnetic surveys, the position of the earth's magnetic north pole has been located about 200 miles away from where it was previously known to exist

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The Governing Body of the Council of Scientific and Industrial Research which met in New Delhi on September 16, 1946 under the chairmanship of Mr C Rajagopalachari, Member for Industries and Supplies, sanctioned, on the recommendation of the Advisory Board, several new schemes of research costing about Rs 60,000 The schemes include research on nuclear physics to be carried on at the University College of Science, Calcutta, under Professor M N Saha, and atomic research at the Tata Institute of Fundamental Research under Dr H J. Bhabha and at the Bose Research Institute under Dr D M. Bose.

The Governing Body also approved the final plans for the establishment of the Fuel Research

Institute and the National Metallurgical Laboratory in India The Fuel Research Institute is to be located at Digwadhi near Dhanbad at an estimated capital cost of Rs 14 lakhs and Jamshedpur has been approved of as the site of the National Metallurgical Laboratory which will involve a capital expenditure of Rs. 42 8 lakhs Architects for these laboratories have already been appointed by the Council, and detailed estimates, plans and designs will be submitted by them for the approval of the Council

In his welcome address to Mr Rajagopalachari as the new President of the Council, Sir Shri Ram eulogized his services to the country and his great independence of outlook and pointed out that, with its limited resources, the Council had done very useful work during the war and had succeeded in mobilizing the talent of the country to a great extent Mr Rajagopalachari, in his reply, emphasized that the Board should aim at real help to industry He deplored that India had to depend on other countries for food He felt that things would have to be organized so that, in matters of food and clothing, India need not depend on external assistance and that any industrial development assuming this must have priority

AGRICULTURAL RESEARCH AND FOOD PRODUCTION

"Ultimately, all research must be judged from the contribution it makes to the welfare of the masses A poor country like India can ill-afford ivory-tower research divorced from the realities of life and the needs of its cultivators It is the needs of the cultivators which research workers must always keep in view", thus observed Dr Rajendra Prasad, Member for Food and Agriculture, presiding over the sixteenth meeting of the Governing Body of the Imperial Council of Agricultural Research, held recently at New Delhi "Agricultural research", he said, "which places in our hands means of increasing the food supply of the country, should have the highest priority" and the immediate task was to step up food production so that all persons in the country could have two square meals a day We have now to rectify the ill-balance between population and food production, in the country, by producing better and more food Research workers in India must concentrate on the task of evolving better and high yielding varieties of crops, in discovering better agricultural practices and in placing more efficient tools in the hands of the cultivators

"Our main problem is to link our man-power with the vast material resources of the country and to develop them according to plan In planned scientific development lies the salvation of the country and in this great task scientific research workers, particularly those who have chosen agriculture and animal husbandry as fields for their activities, have a great task to perform "

Agricultural research in this country has provided high yielding sugarcanes, wheats, cottons, and paddies to the cultivator but even in respect of these, our production is very much less than what it is in other countries The average annual yield per acre of rice, wheat, cotton and sugarcane in India is 851 lbs , 636 lbs , 819 lbs , and 383 mds respectively, whereas it is 1,333 lbs in U S A , 972 lbs in Canada, 531 lbs in Egypt, and 1,446 mds in Java respectively

Speaking of the I C A R , since its birth in 1929, Dr Prasad said that the Council had performed great service to the people "By promoting, guiding and co-ordinating agricultural and veterinary research in India, by training research workers and collecting and disseminating information on research through its publication, the Council has been performing a useful function"

Concluding Dr Prasad added, "Science in the service of the country must be our ideal It is generally admitted that investment in scientific research is the best investment which a nation can make as the returns which it provides are out of all proportions to the money invested " As an example, he cited the case of sugarcane development in this country, which has saved the drain of millions of rupees to foreign countries

The Governing Body sanctioned 10 schemes of research on agriculture and 12 on animal husbandry It was further decided to change the name of Imperial Council of Agricultural Research to Indian Council of Agricultural Research.

BOTANY DURING THE WAR

THE story of the fate of a large and valuable collection of over 3,000 specimens of Malaysian hepaticae, chiefly epiphytic Lejeuneaceae of great interest from the point of view of Indian Botany, during the war years, is now told by Dr F Verdoorn The specimens were collected by Dr Verdoorn in 1925-26 and belonged to the Farlow Herbarium, Harvard University, which were on loan, at the out-break of the war, to the Botanical Institute of the University of Jena The specimens were placed in a country home near Jena, as a safety measure during the early war years This house was entirely destroyed by bomb but the specimens were found in an undamaged condition in the wreckage of the basement. The specimens were then transferred to a part of the basement at the Botanical Institute. This building was entirely destroyed when nine students were killed and the director, Prof. Renner, seriously wounded The hepaticological collections were fortunately in a wing where the basement withstood the bombing

Prof. T Herzog, Drs Benedict and Schuchardt are now continuing work on this collection.

Dr W Robijns, director, Jardin Botanique De l'Etat, Brussels, reports that the collections (consisting of 1,100,000 specimens) are all safe A part of the gardens (consisting of plants of Belgian Congo) has been destroyed During the occupation, the scientific activity of the institute was not only maintained but extended The Bulletin was issued regularly once a year, instead of twice a year A plan for the flora of Belgian Congo comprising 20 volumes for the spermatophytes was started and the manuscript for Vol. 1 is completed

Dr Posthumous, head of the department of Plant Breeding, Buitenzorg, Java (Netherlands East Indies), reported that about 110 members of the staff were interned by the Japanese At least 25 per cent of the internees died, some of them by execution

THE EFFICIENCY OF ENUMERATIONS

This work was taken up as a result of a resolution on the subject adopted by the sixth Silvicultural Conference held at Dehra Dun in April, 1945 The enquiry is necessitated by the general overfelling of the forests of India for war purposes, that has rendered it imperative, large-scale enumerations in a number of provinces for working plan purposes, in order to estimate war damage and remaining resources and also for providing data for post war planning

The conference resolved (*Indian Forest leaflet*, No 83, I—The Problem) that

(1) the Central Silviculturist be authorized to proceed at once with the examination of existing data to endeavour to give an indication as soon as possible by the probable accuracy of different methods and intensities of enumeration in different types of forest and terrain

(2) approximate information is needed quickly rather than a more detailed accurate complete research ,

(3) the staff used for enumeration work should be of highest quality available and should receive extra remuneration , and

(4) after the examination of this data a paper or a leaflet should be written on the necessity for determining the precision of sampling operations

Soon after investigations commenced and *leaflet* No 84 (II—Madras Tropical Wet Evergreen forest , III—typical calculations), the first report in the series is the first of its kind in India and only deals with one piece of one type of forest and it is emphasized that other types of forest and terrain and other types of country may give different results It indicates the probable errors of our correct enumeration work This leaflet examines the data available of a compact area of 791 acres of Madras Evergreen forest and shows what errors in estimations of total volume would have occurred had "sampling enumerations of different intensities been carried out instead of a full 100% enumeration" The work has led to the following indications —

(1) intensive and extensive 100% enumerations are NOT necessary in order to obtain a reasonable estimate of the growing stock Enumeration of 5% or 10% are probably sufficient for most practical purposes ,

(2) systematic sampling gives us more accurate estimations than random sampling, provided it is carried out with a full appreciation of the probable trends of the fertility gradients of the forest ,

(3) whatever the intensity of enumeration some 30 to 60 separate estimates of the volume per acre in each square mile of forest will probably give us a sufficiently accurate estimate of the total volume of commercial timber accurate for all normal working plan purposes

Leaflet No 85 (IV—Madras Moist mixed Deciduous Forest)

Results obtained in this area (of 2,212 acres) agree very nearly in general with the results obtained from a Madras Evergreen Forest Enumeration of 2½% or 5% in moist deciduous forests are probably sufficient (2) Whatever the intensity of enumeration some 10 separate estimates per sq mile in moist deciduous forest will give us a sufficiently accurate estimate of total volume and enable to calculate its precision These are economically reasonable numbers of figure for the computors to calculate with

In *leaflt* No 86 (V—Upper Assam Tropical Evergreen forest , VI—typical calculations), the data available (of 1,832 acres) show that it is very likely that the idication afforded by the Madras data will apply to Assam evergreens

Leaflet No 87 (VII—The distribution of the volume of figures) justifies statistically the using of certain mathematical methods and applying the normal laws of probability in the examination of the enumeration data which were analyzed in leaflets No 84 and 85 It is justifiable to treat the volume figures as normally distributed population, although in fact they are not actually so distributed

Leaflet No 88 (VIII—*Chir* (*Pinus longifolia*) forest in the Punjab and United Provinces)—This leaflet deals with the examination of the data of 13,976 acres of *Chir* forest of the Punjab with confirmation, by the data of a small area of some 32 acres in the United Provinces Enumerations of 5% to 10% in *Chir* pine forest is sufficient

The enumeration data analyzed in this leaflet is justified applying the normal laws of probability to skew distribution in *leaflet* No 89 (IV—The distribution of the volume figure)

Leaflet No 90 (Hill Sal *Shorea Robusta*) forest in the United Provinces deals with the examination of the data of 48,284 acres of hill *sal* forest of the U P The data is poor as the units of enumeration are large (about 200 acres each) and in consequence few in number.

In *leaflet* No 91 (XI—The distribution of the volume figures) the enumeration data given in leaflet No 90 are justified applying the laws of probability These data indicate that 100 per cent enumerations are not necessary and provided proper regard is paid to fertility gradients, some 5 or 10 per cent sample is sufficient.

These leaflets are recommended for critical study by all those in charge of forest areas not only in India but in other countries as well, where forests have suffered due to unchecked fellings during the World War II Such wholesale stock-taking of Indian forests is commendable, and we draw attention to its practical value

FOURTH INTERNATIONAL CONGRESS FOR MICROBIOLOGY

NEWS has been received at the office of the Indian National Committee of the International Association of Microbiologists that the Fourth International Congress for Microbiology will be held at Copenhagen, Denmark, from July 20-26, 1947 The business of the Congress will be conducted through 9 sections, as follows:—

Section I—General Microbiology ; Antibiotica , Growth substances. *Section II*—Medical and Veterinary Bacteriology , Diphtheria , Pertussis , Pathogenic streptococci , Tuberculosis , Brucellosis *Section III*—Viruses and Viral Diseases , Poliomyelitis , Influenza. *Section IV*—Serology and Immunology , Fundamental principles of serology, partly in relation to infection-biology, partly from physical and chemical view-points *Section V*—Variation and Mutation in Micro-organisms , Adaptation , Induced mutation *Section VI*—Plant Pathology and Mycology ; Plant pathogenic bacteria—their taxonomy and nomenclature , Nomenclature of plant viruses , Physiologic (pathogenic) races of fungi , Fungus flora and decay in wood pulp *Section VII*—Water and Soil Microbiology , Antibiotic activity in the soil ; Nodule bacteria and nitrogen fixation in the soil ; Microbiological methods for determination of soil fertility ; Autotropic bacteria ; Methods for quantitative determination of Escherichia coli in water ; Pathogenic bacteria in sewage , Bacteriology of the biological purification of sewage *Section VIII*—Dairy and Food Microbiology ; Sourmilk for therapeutic purposes ; Lactic acid bacteria in silage ; Food poisoning *Section IX*—Alcoholic and other fermentations, Butanol-acetone fermentation ; Food yeast

The International Society for Microbiology was established in 1930 "with the object of promoting secientific thought by creating a closer relationship between scientific workers in different countries, and especially of spreading the idea that all its members were united in a common ideal of peace and constant friendship."

The Society is directed by a Central International Committee and a Permanent Commission The Central Committee is composed of members of the Society's Board, the members of the Permanent Commission and the Chairmen of the National Committees.

Each country or geographical region forms a National Committee made up of workers in various universities, research institutes and other institutions concerned. The constitution enjoins that workers wishing to contribute papers must apply for membership through the National Committee of the country concerned and when the Central Committee approves of such application, they then become full members on payment of the required fee The office of the Fourth International Congress is located at Kommunehospitalet, Copenhagen, Denmark. The office of the Honorary Secretary, Indian National Committee (Dr A. C Ukil), is located at the All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta, from whom further information on the subject can be obtained

For the information of those who will contribute papers, it is stated that a summary not exceeding 200 words should be in the hands of the General Secretary of the Congress at Copenhagen not later than the 1st January, 1947.

AGHARKAR COMMEMORATION MEDAL

THE 'Agharkar Farewell Committee' has created an endowment for the award of a medal to graduates in botany of not more than 10 years standing or M.A. or M Sc.'s in botany of not more than 8 years standing of the Calcutta University on the merits of published original contributions in any branch of botany.

The object of this endowment is to commemorate the varied services of Prof S. P Agharkar, M.A , Ph.D, Sir Rash Behary Ghosh Professor of Botany, Calcutta University (Retired), for the cause of advancement of science in general and botany in particular in India.

The first award of the meral (Gold) will be made by the Indian Botanical Society, on the occasion of its Silver Jubilee meeting to be held in December next at Allahabad. Candidates desirous of competing for the medal are requested to send reprints of their papers with statement of academic qualifications, to the Hony. Secretary, Indian Botanical

Society, Botany Department, The University, Lucknow, so as to reach him not later than 31st October, '46.

ANNOUNCEMENTS

THE undermentioned candidates have been awarded Senior Research Fellowships of the National Institute of Sciences of India of the value of Rs 500/- a month on the subject mentioned against each —

Botany—Dr P N Bhaduri, Ph D, F N I, Calcutta University,

Chemistry—Dr K. Subbarao, D.Sc, Central College, Bangalore,

Geography—Dr M. B Pithawalla, D Sc, Bombay University,

Physics—Dr F C Auluck, D Sc, Delhi University,

Zoology—Dr M A H Qadri, D Sc, Muslim University, Aligarh

The following have been awarded Junior Research Fellowships of the value of Rs 350/- a month. —

Botany—Dr C. T. Datta, Ph D, Calcutta University,

Chemistry—Dr D. K. Banerji, D Sc, Calcutta University and Dr N L Phalniker, D Sc, Maharajah Pratab Singh Chemical Laboratory, Pooan;

Physics—Mr A K Saha, M.Sc, Calcutta University and Mr K S. Singhvi, M.Sc, Allahabad University,

Zoology—Mr P A R Iyer, M Sc, Central College, Bangalore.

It may be mentioned here that these fellowships were instituted with the grant from the Government of India

THE International Association of Wood Anatomists has elected Dr K A Chowdhury, M B E, D Sc, F.N I, Wood Technologist, Forest Research Institute, Dehra Dun, to its Council He is the first Indian scientist to be elected to the Council of this international organization.

ERRATUM

On page 151 of the September, 1946 issue in line 13 (column 1) *read* 45 μg *for* 45 g

SCIENCE IN INDUSTRY

CATHODIC PROTECTION OF PIPE LINES

THE use of zinc for cathodic protection, which has a number of advantages in engineering and industry, forms the basis of an interesting article by H. W Wahlsuist (*Corrosion*, vol 1, No 3, Sept 1945, p 119). According to this author, zinc anodes have been used for nearly 70 years in marine installations for preventing corrosion of propeller shafts in fittings on the stern of a boat It is only in recent years, however, that the practicability of using zinc anodes in the cathodic protection of pipe lines has received attention.

The use of zinc as a current source in cathodic protection has a number of advantages in cases where soil conditions are favourable. The cost of installing and maintaining zinc installations is usually less than the normal type of sources like rectifiers, motor generators or gas engines With zinc, there are no off-time periods such as those which frequently occur with gas engines and windmills, a consideration which is usually given too little weight in evaluating the merits of various current sources. Zinc can be efficiently adapted for use on either bare or coated pipe lines, with the specific advantage of economically protecting any specific locations on the line which may be highly anodic to other sections As these locations are usually far away from power lines, the use of rectifiers becomes impracticable Also since zinc anodes serve both as a current source and as a ground bed, the difficulties of providing and maintaining large masses of metal in extensive ground beds is avoided In fact, in large cities and in congested areas, zinc anodes serve as an excellent means of protection to coated lines, as their adoption in no way interferes with neighbouring structures. The author has also vividly brought out the fact that at present no authoritative information is available on the long-term performance of zinc in the various types of soils, when used as a current source in cathodic protection It is believed that this metal may not be useful in locations where high soil resistivity limits the current output to small values. With increasing experience and knowledge in this field however, these limitations may be overcome. The study of the behaviour of buried zinc-iron couples in different types of soil

which is in progress by the U S. Bureau of Standards since 1941 may provide some valuable data in this connection on the complicated electrochemical reactions of the different soils. Information concerning the nature of the corrosion products that are built up on the zinc surface is also not complete Soils which tend to produce insoluble, high-resistance films having low porosity would tend to reduce current output due to increased circuit resistance If these effects were not too pronounced some compensation for them might be secured by the use of anodes having a high ratio of surface area to volume The resistance to earth of a zinc rod when installed initially is governed by the same laws that apply to driven grounds or other metallic structures in a conducting medium It appears possible that impurities in the zinc could have an effect on the over-all behaviour of the anodes over a specific period of time

In the absence of all such information, especially long-term tests, the determination of the ampere-hour output expected of zinc anodes for a period of 15 to 20 years or more becomes extremely difficult Some investigators record the passivity of zinc anodes after only two or three years action in the soil, whereas other experimenters give evidence of a satisfactory performance of zinc anodes in arresting corrosion for periods varying from three to eight years The author's paper in this connection throws some valuable light on the observations made by him, such as the character of corrosion products on zinc anodes buried in various soils , effect of changes in film potential of, and of impurities in, zinc anodes , nature of local action currents from different soil strata , effect of current density on the behaviour of these anodes, and the effects of the use of chemicals to reduce the passivity of zinc anodes Actual tests have also been carried out by the author on zinc protected lines in Colorado and Houston in U S A and valuable results drawn therefrom as regarding zinc output and potential record , comparison of current outputs of various zinc plate installations on various types of backfills , comparison of A C and D C resistance measurements on special test zinc plates , ohmic resistance of zinc to waterpipes , and a theoretical evaluation of the life of zinc plates The results of these tests provide encouraging evidence as to the practicability of using zinc under a wide range of conditions ; however they also bring out the need for a more intensive study of the behaviour of zinc used as an anode in soil electrolytes

S K G

GLASS AND CERAMICS INDUSTRY IN JAPAN

AN account of Japan's glass and ceramics industry during the war and at present appears in a recent issue of the *Chemical Age* Considerable expansion took place in the optical industry and also in glass and ceramics Before 1936, her annual outturn of optical glass stood at the insignificant figure of 13 short tons only , in 1944, this output had reached a figure of 475 short tons valued at over 223,000 yen The real intensive development in the industry, however, took place after Pearl Harbour, when production increased materially every year Her present stock of optical glass amounts to about 300 short tons, valued at over 15,700,000 yen, and despite some damage being done to the industry by fire during the war, the capacity of the existing plants has been estimated at 300 short tons per annum Because of large stocks, production is now reported to be at a stand-still

Before the war, Japan was the second largest producer of sheet glass, after U S A The industry was mainly controlled by two concerns the Mitsubishi Chemical Industrial Company Limited (formerly Asahi Glass Company), and the Nippon Plate Glass Company Limited, with plants at Amagasaki, Makiyama, and Tsurumi, and at Wakamatsu and Yokkaichi respectively The industry's present capacity is estimated at 150,000 cases (of 100 sq ft) per month, while the potential monthly output amounts to 500,000 cases

In 1938, she had 1080 glassware factories with a combined output of over 506,000 tons Heavy war time pressure on raw materials led to a concentration on essential production lines, and the plants were rationalized in 1941 and 1943 The number of glassware factories was reduced to 180 with a total annual capacity of 156,300 tons Present monthly output is stated to be 1500 tons

Considerable deterioration in the ceramics industry is reported This industry was developed in Japan primarily on the lines of cottage industry, small unit being operated as family business employing less than five workers In 1938, 6500 units were in operation , the present figure is not quoted The refractory industry which formerly maintained an expert trade in vitreous enamel ware, including chemical ware, is now operating in a very limited scale The present capacity is estimated at 118,500 tons monthly which shows some improvement over the production in December 1945, when only 12,523 tons of products, including 10,000 tons of fireclay, were manufactured

ELECTRONIC COMPUTER

AN Electronic Numerical Integrator and Computer, abbreviated into Eniac and capable of solving complex and difficult problems in an incredibly short time, has been recently announced by the U S War Department The electronic computer is reported to have completed in two weeks the solution of a problem which would have required 100 man-years of trained computer's work The actual computing

by the machine required two hours, and rest of the time was occupied by the review of results and details of operation.

The electronic computer depends for its working on nearly 18,000 vacuum tubes The whole machine weighs about 30 tons and occupies a floor area of 1,500 square feet The Eniac was originally developed to compute lengthy and complicated firing and bombing tables for vital ordnance equipment , it is expected to play an equally important role in complex peacetime problems in nuclear physics, aerodynamics and scientific weather prediction.

PERENNIAL WHEATS

In a short note in *Discovery*, June 1946, Academician Nikolai Tsitsin describes the Soviet efforts at producing hybrid wheat First attempts in this direction took place about fifteen years ago, at the 'Giant', State Farm in the Northern Caucasus, where the first hybrid wheat was produced by crossing wheat and couchgrass Subsequently, Soviet workers have 'discovered five varieties of couchgrass which can be effectively crossed, not only with any variety of wheat, but also with rye, as well as with certain wild species of wheat called *Triticum aegilops* ' A number of new varieties of summer and winter wheat, possessing complex properties of great agricultural importance, have been developed by hybridization and selection These researches further led to the development of another important variety, the perennial wheat, 'which having been once sown, yielded from three to four crops' This hybrid was produced by crossing wheat with couchgrass. Later new varieties suitable for sowing in any areas of the agricultural zone were developed, and present research is concentrated on speedy reproduction of these new varieties of perennial wheat

Academician Tsitsin further reports Soviet success in overcoming the resistance of wheat and barley to crossing with another remarkable wild-growing plant belonging to the genus *Elymus* Very important hybrids known as Wheat-Elymus and Barley-Elymus hybrids, capable of bearing 200 to 300 or even more grains to the ear, as against the usual 30 or 40, have been obtained This is a remarkable achievement and will greatly contribute to crop yield These hybrid varieties are so strong and resistant that semi-waste land can be planted with them and thus used to the fullest extent possible.

NOISE AND ITS INSULATION IN BUILDINGS

KARMAVIR MITAL

(Continued from previous issue)

Methods of Sound Insulation

The problem of noise insulation can now be stated more exactly as follows. Suppose we have to make a residential house in a noisy street with heavy traffic and a few factories running in the neighbourhood The noise level in the street at the place where the house is proposed to be built is, say, 70 db (decibels) The maximum noise that can be tolerated inside the proposed house is 20 db Thus we have to provide such insulation that 50 db of noise is absorbed by the walls of the house, or to put it technically, the average transmission loss (T I) due to the outside walls is 50 db.

Methods of sound transmission —Having stated the problem thus, we proceed to discuss the various means of transmission of sound in a building In order to be able to handle the problems of sound insulation intelligently, it is necessary to have a clear conception of the mechanisms by which sound may be transmitted through partitions and building structures The principal means of transmission are as follows.—

(1) As air-borne waves through air-gaps in windows, doors, cracks round doors, ventilating ducts, openings through badly fitting door-leaves etc

(2) As solid-borne vibrations, *i e* , vibrations in the solid structure in the building These vibrations can be further sub-divided into three classes —

(*a*) As vibrations which originate and progress through the solid structure and eventually make themselves heard as sound, *e g* , foot-falls, hammering on walls and floors, moving of furniture, etc.

(*b*) As sound waves through solid partitions transmitted according to the laws of refraction, just as light waves are transmitted through transparent media

(*c*) As sound transmitted by the diaphragm action of the partition when it vibrates as a whole in unison with the vibrations in the air.

We shall discuss these cases in details one by one.

Air-borne transmissions.—This is by far the most important way and contributes most to the transmission of noise. Sound is most readily transmitted through air openings, and as long as they exist, it is futile to provide a relatively high insulation through solid partitions, ceilings and floors. The first prerequisite of sound insulation is, therefore, very closely fitting doors and windows and complete absence of cracks, holes and other minor air gaps which to a lay man may appear harmless. Even the smallest opening sometimes transmits more sound than the whole solid structure. Simply reducing the size of an air opening has relatively little effect upon reducing the intensity of sound transmitted. This is due to two causes: (1) Sound passing through small opening is so much diffracted that the opening itself acts as a sufficiently strong secondary source of sound from where it spreads in the whole room as spherical waves. (2) Loudness as perceived by the ear is proportional to the logarithm of the intensity of sound and, therefore, a large decrease in intensity by narrowing down the opening results in a comparatively much less decrease in loudness. To take a numerical example, suppose an opening 10 sq. cm. in area is reduced to 1 sq. cm., then the intensity of sound transmitted through it is reduced ten times (only if the diffraction effects are neglected) which means a decrease of 10 db in loudness. Thus a noise level of 50 db is brought down to 40 db, and by a further narrowing down of the opening to 0.1 sq. cm. the noise is reduced to 30 db. The reduction of noise is thus not very appreciable even though the opening has been reduced to its hundredth part. The complete closing of the hole, on the other hand, will bring about a sudden and large reduction in loudness. It is common experience how a noise can be kept out by closing the doors, windows and ventilators. The real problem of the architect, in fact, begins after all the direct air openings have been closed completely. We say 'direct' because ventilation is even more important than sound insulation and an architect would indeed be foolish if he were to make air-tight buildings with no provision for ventilation at all. Doors, windows and ventilators have got to be provided as usual, but in order to make the building sound-proof, care has to be taken to make them closely fitting. Felt or mineral wool or such other sound absorbing material may profitably be provided on the edges between two door-leaves, or between door-leaves and their supporting frames. The advantage is double. There will be no clashing noise while opening and closing the doors and windows hastily and carelessly. Also when shut, they will fit against each other better and will close any possible air-openings, or at least will reduce the intensity of sound transmitted through them due to the presence of the sound absorbing material.

Ventilation in a modern building is usually provided with an air-conditioning equipment*. Ventilating ducts, connecting various rooms to the air-conditioning equipment and often incidentally connecting rooms among themselves also, provide an easy passage to the noise from one room to the other and also from the machinery of the air-conditioning plant. This noise can be controlled, first, by selecting a not very noisy equipment, and second, by installing it in a room with walls and ceiling treated with a highly sound absorbing material. As for the ventilating ducts, experiments have been conducted to study sound transmission through narrow tubes. It has been found that acoustical attention (or fall in loudness) for a sound transmitted through a narrow tube is (1) directly proportional to the length of the tube, (2) inversely proportional to the radius of the circular cross-section of the tube, and (3) proportional to the absorptivity of the material of the inner side of the tube. The ducts should, therefore, be taken as long and as narrow as can be conveniently done and should be lined on the inside with hair felt or some other good absorber of sound. Fig. 2

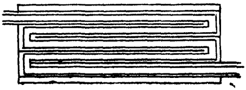


FIG. 2

suggests how the length of the ducts can be increased without actually taking it for long distances.

Solid-borne vibrations.—Vibrations produced in and carried through the solid structure are of extreme importance and have to be considered very carefully. Vibrations produced in floors and walls by foot-falls, moving of furniture, hammering etc., are readily taken up by the whole structure and transmitted to long distances without much attenuation. They are not communicated to the air around until some partition with a natural frequency of vibration in unison with the imposed vibrations starts vibrating like a diaphragm. The solid structure is sometimes capable of transmitting vibrations to large distances in the building and so a noise is sometimes produced in an apartment quite far off from the place of its origin.

* It is not true of India. But then sound insulation itself is almost the last refinement in a modern building, and before going for that we are expected to have other refinements such as heat insulation, air-conditioning etc. Apparently India lags behind in all these things and till she comes abreast, our interests in these subjects are more or less academic.

The first obvious precaution that can be taken to minimize such noises is to make the 'impact' or 'contact' which starts the disturbances as noiseless as possible by such devices as carpeting the floor and providing the legs of the furniture with rubber paddings The real solution of the problem, however, consists in introducing structural discontinuities in the building so that vibrations of one structure may not be táken up by the other Experience shows that monolithic structures like cement-concrete are better carriers of solid-borne sounds than brick-work, because, in the latter, mortar, with physical properties different from those of brick, introduces a discontinuity in the structure If two solids are connected through a material whose density and elasticity are very different from those of the material of the solids, it is found that, in general, vibrations in one are not communicated to the other without any modification It can be so arranged by taking a connecting link with suitable physical properties of elasticity and density that the modification produced in the vibrations is to our advantage To understand the mechanism of such transmission correctly, and to be able to apply it with success to the problem of insulation of solid-borne sounds in structures, it is necessary to go a little into theory

Theory of transmission of vibrations through elastic connection —Let M and m be two masses (Fig 3) connected together by a support having

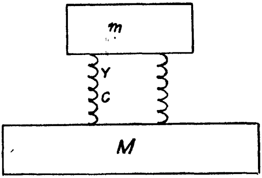


FIG. 3

definite elastic and flexible properties, and let M be vibrating with a frequency n and amplitude a_1 under the action of some vibromotive (i e, vibrations producing) force Due to the elastic coupling between M and m, the mass m will also begin to vibrate, but with an amplitude a_2, which is, in general, different from a_1. The system is the mechanical equivalent of an oscillating electrical circuit Much progress has been made during the last twenty-five years in the study of mechanical vibrating systems through comparison with analogous electrical circuits, and it is possible to obtain a solution of the former by methods similar to those of the latter Without going into the mathematical details which are beyond the scope of this article, we shall take the solution for the ratio $\frac{a_2}{a_1}$ as

$$\frac{a_2}{a_1} = \sqrt{\frac{r^2 + \frac{1}{4\pi^2 n^2 c^2}}{r^2 + \left(2\pi n m - \frac{1}{2\pi n c}\right)^2}} \quad \ldots\ldots \quad (2)$$

where r^2 and c are respectively the 'resistance' and the 'compliance' of the elastic coupling They are analogous to resistance and capacity in an electrical circuit Resistance r is refined as the rate at which the free vibrations of the mass m upon the elastic support will be damped, and the compliance c is defined as the compression in cms produced by the application of a unit force (1 dyne) upon the flexible support These two quantities defining the physical characteristics of the elastic support, together with the supported mass m and the frequency n of the imposed vibrations upon the mass M, determine the ratio $\frac{a_2}{a_1}$, which may be interpreted physically as a measure of insulation of vibrations produced by the elastic coupling.

Examining equation (2),

(*i*) If $2\pi n m$ is very small as compared to $\frac{1}{2\pi n c}$ i e, if n, the frequency of imposed vibrations is very small as compared to the natural frequency of vibration of the mass m upon its elastic support, then $a_2 = a_1$, i e, the vibrations are transmitted without any damping or amplification.

(*ii*) At resonant frequency, i e, when $2\pi n m = \frac{1}{2\pi n c}$, $a_2 > a_1$, and the vibrations are amplified. Also $a_2 > a_1$ for all values of n such that $2\pi n m - \frac{1}{2\pi n c} < \frac{1}{2\pi n c}$

or $2\pi n m < \frac{1}{\pi n c}$

or $n < \frac{1}{\pi\sqrt{2mc}}$

(*iii*) For all values of

$$n > \frac{1}{\pi\sqrt{2mc}} \quad \ldots\ldots \quad (3)$$

$a_2 < a_1$,

i e, the vibrations will be damped as a result of the elastic coupling

Thus we see how important it is to understand the theory behind the procedure of inserting elastic discontinuities between the various structural parts of a building for the purpose of insulating solid-borne

vibrations. An indiscreet insertion might amplify vibrations instead of damping them

In order that the elastic discontinuity inserted between two rigid partitions may be effective in damping vibrations, equation (3) must be satisfied m and c should be sufficiently large so that even low frequency vibrations (n may be damped The mass supported by the elastic connection should be as large as possible and the support should be as elastic as possible. Obviously there are physical limitations to both these quantities Too heavy a mass may crush the elastic connection and thus make it lose all its elasticity We have to make a judicious selection of the insulating connection so that compliance c for it may satisfy equation (3)

In the above discussion we have limited ourselves to sustained periodic vibrations as may often be produced by running machinery like fans, motors etc Transient vibrations, in the form of shocks, are also effectively damped by similar methods Only the resistance of the elastic coupling should be relatively large in this case A large mass connected by a very elastic device with a little larger resistance will very effectively damp transient vibrations

There are laboratory methods of determining compliance and resistance of elastic materials which we do not propose to discuss here. We, however, give below a table giving the compliance of a few elastic materials, commercially available for building construction.

TABLE III

Material	Description	Approx upper safe loading in lbs /sq cm	Compliance in cms per dyne × 10^{-6}
Cork board	1.1 lb per board foot	12	0.25
Celotex	Insulating board	12	0.18
Masonite	Ditto	15	0.12
Sponge rubber	25 lbs per cubic foot	1–3	3.0
Soft India rubber	55 lbs per cubic foot	3–6	1.2
Hair felt	10 lbs per cubic foot	1–2	1.5

The compliance in the above table is for specimens 1″ thick and 1 sq cm in cross section. It can be determined for specimens of different sizes by remembering that c is directly proportional to the thickness and inversely proportional to the area of the specimen.

In the light of the above theory we proceed to describe some devices which are used in the isolation of floors, ceilings, walls and rooms from the main structure of the building.

Isolation of ceilings and floors.—Ceilings can be suspended from structural roofs by means of elastic supports Figs 4 (*a*) and (*b*) show two views of an

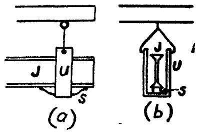


FIG 4

isolator in which a joist 'J' is supported upon a steel spring, 's', resting on a U-shaped iron piece 'U' hung from a concrete roof The ceiling board (not shown in the figure) is to be attached to the joist. Thus the ceiling has no rigid connection with the concrete roof, the only link between the two being the elastic spring, 's', which effectively insulates the ceiling against the vibrations in the roof Another type is shown in Fig 5 The hook 'H' to which the ceiling board is to be attached is connected to the piece 'P_1' which rests upon an elastic cushion 'C' placed upon piece 'P_2', hung in its turn from the main roof. Here again the only connection between the upper roof and the lower ceiling is through the flexible cushion which acts as an effective damper of

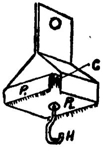


FIG 5

vibrations In all cases the compliance of the elastic material should carefully be considered in relation to the weight of the ceiling supported and the approximate minimum frequency of the vibrations to be cut off It is not difficult to choose the proper material after doing a little calculation based upon equations (2) and (3).

To obtain an isolated floor, an additional floor should be floated on the structural floor by means of soft insulating materials like rubber, cork, felt etc, or flexible steel chairs Flexible steel chairs have been found to be more effective than substances like cork or felt. Fig. 6 shows a section through an

additional wood floor floated on steel chairs upon the original concrete floor.

FIG. 6

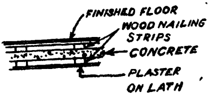


FIG. 7

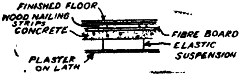


FIG 8

Partitions of very high insulation value can be devised by combining the above two methods, *viz.*, hanging the ceiling and floating the floor from the concrete structure. Figs. 7 & 8 show sections through two such ceiling-floor partitions They are only two of the many combinations we can have of concrete slabs, fibre boards, wood laths, wood joists, flexible steel chairs etc, to give a very high degree of sound insulation.

Isolation of walls and rooms.—The complete isolation of walls, ceiling and floor is required only in the rooms of acoustic laboratories or sound studios of motion pictures The former require that even the earth-borne vibrations and tremors such as caused by running railway trains should not be communicated inside the room. For such complete insulation, double walls having no rigid structural connection between them have got to be provided Main structural walls are necessary to bear the load of ceilings etc The inside of the room to be insulated is further provided with comparatively light-panelled walls isolated from the main walls, ceiling and floor from all sides by flexible material like rubber or cork. The elastic material has again to be chosen with due regard to its compliance and resistance required under the circumstances

Requirements of experimental chambers of acoustical laboratories are such that the whole rooms have to be floated on elastic bases in order to keep them free from earth and building vibrations. The construction of the reverberation room of the Acoustical Laboratory at the University of California is a typical example of such complete insulation Fig 9 shows a section through the room The reverberation chamber is constructed of 12″ concrete walls and a 6″ concrete ceiling slab, and this chamber is inside the main concrete frame of the building.

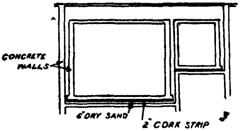


FIG. 9

The whole room is insulated from the ground and the main structure by means of (1) a 6″ fill of dry sand enclosed in a concrete pan and (2) strips of 2″ insulation cork placed directly under the concrete floor The sand offers a discontinuity in the path of earth-borne vibrations, and the cork prevents sustained solid-borne vibrations in the audible range from reaching the chamber

Refraction of sound through partitions.—Refraction, as a method of transmission of sound through solids, is of little consequence. By theoretical calculations it can be shown that the intensity of a wave transmitted from air to air through a solid material like brick or stone by the process of refraction is less than a millionth part of the incident intensity This method of transmission is, therefore, of no consequence at all and need not be considered.

Insulation of sound by partitions.—Now we come to the third important way in which sound may be transmitted in a building, *viz.*, through the partitions by the process of forced vibrations. Such vibrations are set up most readily and carry maximum energy at the resonant point, *i.e.*, when the natural frequency of vibration of the partition happens to be equal to the frequency of the incident sound Therefore, a partition may be expected to transmit a relatively large amount of energy for certain frequencies corresponding to its fundamental frequency and a series of overtones. In actual practice, it is, however, found that these frequencies are not sharply defined in an average type of partition but are flattened out because of internal damping of the material of the partition.

The degree of insulation offered by a particular partition is best determined experimentally, and the study of the insulative properties of various types of panels used as partitions is mostly experimental.

The insulation value of a partition may be expected to depend upon (1) its weight per unit area, (2) its material, (3) stiffness of the material (on which will depend damping), and (4) size of the partition By taking a test panel of sufficiently large size, it may be assumed that the frequency of free vibrations of the test panel is the same as that of the wall as a whole, and thus the experimental determination of insulation produced by a test panel can be taken to be the same as the insulation of the wall of the same materials, thickness and section

Measurement of insulation—The insulative property of a test panel is measured in terms of either (1) the coefficient of transmission, or (2) the transmission loss, or (3) the reduction factor We shall first define these quantities and then proceed to indicate very briefly the methods of determining them

Suppose 'AB' (Fig. 10) is a test panel fastened securely round its edges in a window of proper size between two rooms 'S' and 'T' of an acoustic laboratory The two rooms are such that no sound can travel in between them except through the window

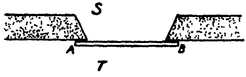


FIG 10

and the test panel Also there are no disturbing sounds from anywhere else in any of the rooms except the sound produced in the source room 'S' for experimental purposes Now, if I_1 is the intensity of sound in the source room side of the test panel and I_2 that on the test room side, the coefficient of transmission, τ, of the panel is defined as

$$\tau = \frac{I_2}{I_1}$$

Transmission loss (T L) in decibels is defined as

$$\text{T.L} = 10 \log_{10} \frac{1}{\tau} = 10 \log_{10} \frac{I_1}{I_2} \quad . \quad . \quad . \qquad (4)$$

If instead of intensity, the volume density of the sound in the source room is measured as ρ_1, and in the test room as ρ_2, $\frac{\rho_1}{\rho_2}$ is defined as the reduction factor of the panel The reduction factor in decibels is then given as $10 \log_{10} \frac{\rho_1}{\rho_2}$

The principle underlying the methods of testing panels for their insulative properties is thus seen to consist in measuring the intensities of sound on the two sides of the test panel The test panel should be sufficiently large in size so that its fundamental mode of vibration may be taken to be the same as that of the wall made of that panel. Also it should be very closely and securely fastened in the experimental window so that no sound may leak round the corners The experimental chambers have got to be acoustically perfect, all the walls, ceilings and floors being good absorbers and insulators, so that no sound may be transmitted by any other means except through the test panel Sounds of various frequencies such as 128, 512, 1024 etc may be employed and an average transmission coefficient for all the frequencies may be finally determined

The sound in the source room may be of a diffuse nature or may be projected obliquely on the panel as an approximately parallel beam which may be rendered so by a paraboloidal reflector of sound with the source at its focus Measurements of the intensity of sound are usually made by a microphone and an amplifier There are also methods of determining the reduction factor of a test panel by making use of Sabine's well-known reverberation formula. Detailed descriptions of these methods do not lie within the scope of this article and, therefore, are not attempted here

Rigid partitions—The insulation value of a rigid partition may be expected to depend in all upon the following factors —(1) its mass per unit area or inertia, (2) stiffness, (3) internal resistance or damping of the material, (4) size of the partition, and (5) the method of clamping the partition In the case of thin flexible partitions (a few examples with T L in db are given in Table IV), all these five factors may contribute to the total amount of vibration imparted to the partition by the incident sound waves In the case of heavy panels, however, it is found that mass is the only efffective factor and the other factors do not contribute anything to the amount of insulation offered by the panel Thus the transmission coefficient of a heavy panel is a function of its mass per unit area only. The type of panels generally used as partitions such as those of wood, concrete or brick are all to be classed as 'heavy' for this purpose. Even a pine wood partition ½″ thick is sufficiently heavy to be included in this class. The actual mathematical manner in which the insula-

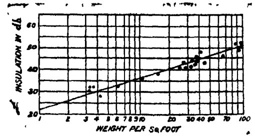


FIG 11

tion value of a rigid partition depends upon its mass per unit area is shown in the graph (Fig. 11) in which the logarithm of weight per sq ft. is plotted against transmission loss in db. The curve is approximately a straight line which shows that the transmission loss of a partition is proportional to the logarithm of the mass per unit area. This fact is of utmost importance as it means that the insulation value of a panel increases slowly with a comparatively rapid increase in mass. Table V illustrates this very well. In it are given the T. L. of brick walls of different widths but similar in all other respects. It can be seen from there that a four times increase in the width of the wall (from 2½" to 10") gives only an increase in T. L. of 7 db. If a panel of mass 10 lbs. per sq. ft. is made ten times thicker and thus its weight increased to 100 lbs per sq. ft., its insulation value increases only from 37 db. to 51 db., which is less than two fold. It is thus seen that increasing the width of a rigid partition is not much effective in increasing its insulation value. Very high insulation value partitions are not, therefore, feasible to obtain by taking thicker and thicker rigid partitions. The cost and the dead load may be tremendously increased without getting the proportionate increase in its effectiveness as a sound insulator. How partitions of very high insulation value (T. L. >50 db) can be obtained will be considered subsequently.

TABLE IV

Description of panel	Weight in lbs per sq. foot	Probable average value of T. L. in db
Aluminium .006"	.075	7
Iron galvanized .03"	1.2	25
Ply-wood ¼", 3-ply	.52	19
Mahogany 1.85"	4.9	28
Sheet iron .08"	3.2	33
Glass plate ¼"	3.5	30

TABLE V

Description of panel	Weight in lbs per sq. foot	Probable average value of T. L. in db
Brick wall plastered both sides 2½"	31	43
,, 4"	46	44
,, 10"	93	50

Porous partitions.—The insulative property of materials like hair felt, mineral wool, fibre board, sail cloth etc, depends upon a mechanism of sound tranmission altogether different from that of the rigid partitions. The sound, in the case of porous material, is transmitted through the capillary pores of the material where it suffers a great deal of attenuation due to the viscous forces in the pores. According to theory, loss in the intensity of sound as it travels through a capillary pore is proportional to the length of the pore, *i.e.*, if by passage through 1" of the pore the intensity is reduced 10 times, by passage through another inch, the intensity should be reduced 10 times more, *i.e.*, 100 times in all. By equation (1)

TABLE VI

Description of Material	Weight in lbs per sq. foot	Probable average value of T. L. in db
Hair felt 0.58"	0.58	4
Hair felt above 2 layers	1.16	9
Above 3 layers	1.74	13
Above 4 layers	2.32	17

100 times reduction in intensity means a fall of 20 db in loudness. The transmission loss in db is thus found to be proportional to the thickness of the porous partition. Table VI which gives the average transmission loss for four layers of hair felt illustrates this law.

Description of wall	T. L. in db
1. Brick wall, 2½", 2" furring strips, celotex lath, plastered on both sides	58
2. Staggered wood studs, plaster on fibre boards on both sides, absorptive blanket between wood studs	50
3. Two masonry walls, each 3", two layers ½" Mutex on each side of a sheet of 28 gauge iron, sandwiched between the walls, plaster on outside	60
4. 2" x 4" wood studs, 1" fibre board on both sides, 3 coat gypsum	49

Sectional sketch

FIG. 12

In the case of rigid partitions the transmission loss was found to be proportional to the logarithm of the thickness (or weight per sq foot) Thus an increase in the thickness of the porous material is proportionately much more effective than an increase in the thickness of rigid partition But as will be seen by a comparison of tables V and VI, the actual average T L in porous material is much less than in a rigid partition T L for a brick wall 2½″ thick is 43 db whereas for hair felt 2 32″ thick it is only 17 db

Special high insulation partitions —As has already been observed, it is neither economical nor feasible to obtain partitions of high insulation value (say of the order of 60 db) by increasing the width of rigid partitions alone. A concrete wall with a T L of 60 db will have to be 4 ft wide Also it is impossible to obtain such high degree of insulation by porous materials alone Theoretically about 15 layers of hair felt ½″ thick will be required to give transmission loss of 60 db It has been found that special structures which combine rigid partitions with layers of porous materials, and are both economical and practical, give the best results Thus two or three rigid but relatively thin partitions separated from each other by felts or blankets can easily be composed to give the desired degree of insulation Such partitions are comparatively cheap and do not increase the dead load of the building unnecessarily However, for the partitions where the dead load is not a serious problem, dense rigid partitions such as plastered brick or concrete provide a satisfactory means of obtaining T L of about 45 db

A large number of special combination partitions have been made and tested by workers in the field of architectural acoustics like Knudsen, Sabine, Meyer and the Bureau of Standards. The general conclusion is that double partitions provide the highest degree of insulation. The separate partitions constituting the single double wall should be as completely insulated from each other as possible, as the introduction of structural ties tends to make the two partitions behave as a single whole The suspension of mineral blanket, fibre board or hair felt, or the use of such commercial sound absorbing materials as celotex, insulite, masonite, etc , adds much to the efficiency of the partition. Above are a few examples of such highly efficient panels with their respective transmission losses and sectional sketches

Conclusion

We shall conclude with the remark that the problem of noise insulation in buildings is essentially a practical problem and needs extensive practical experience before one can claim to be able to give a sound advice on particulars. The above article only indicates the principles underlying the practice which are to be thoroughly understood if unnecessary waste of material and energy is to be avoided by a practical worker In preparing this article the author has freely made use of a number of books on the subject, especially the admirable book, Architectural Acoustics by V O Knudsen, from which most of the important data and diagrams have been taken.

MEDICINE AND PUBLIC HEALTH

COLLEGE OF NURSING IN INDIA

INADEQUACY of Health Personnel in India is emphasized in the 'Report of the Health Survey and Development Committee' (1946). It has been estimated that the number of registered nurses available in India at present is 7,000 i.e., 1 nurse to every 43,000 people. The conditions under which the nurses have to carry on their profession are deplorable. These are lack of professional status, insufficient pay for senior positions, gross under-staffing in hospitals and consequent overwork, deplorable living conditions accompanied by overcrowding and lack of recreational and cultural facilities as well as absence of provision for general superannuation and pension schemes. Without a considerable increase in their number it is impossible to proceed with the development of hospital and other institutional facilities and with the organization of the public health nursing service for curative and preventive work in the homes of the people. The Bhore Committee has therefore recommended that the number of trained nurses available in the country should be raised to 740,000 by 1971, i.e., 1 nurse to every 300 people (this is the ratio existing in the United Kingdom). An essential step towards the achievement of this object is the removal of the existing unsatisfactory condition of training and service.

We welcome the establishment of the 'first nursing college in India' and we hope that more of them will be established in every province so that it may at least be possible to reach the target fixed for the short-term ten-year programme i.e., 80,000 nurses without delay. To raise the number of nurses to 80,000 in ten years is not simple and the establishment of specialized hospitals and schools of nurses is the immediate problem and more so for the fact that the need for nurses is even greater than that for doctors.

In 1943, when owing to the war the need for special preparation of Indian nurses in the fields of administration and teaching became urgent, the Government of India established in Delhi the School of Nursing Administration. Short intensive courses were given to Sisters of the Indian Military Nursing Service and a course in methods of teaching to nurses employed in civil hospitals and schools of nursing. The colleges of Delhi co-operated in providing the external lectures and the hospitals of Delhi in providing the practice field. This School is now being developed to meet peacetime requirements.

The College of Nursing which opens this year as a constituent part of Delhi University offers a four-year preparatory course which will integrate the teaching of health and preventive medicine throughout the entire course. It will prepare nurses to give good nursing care in the homes of both urban and rural areas, as well as the hospital. Other colleges and the hospitals of Delhi are cooperating in the course and it will lead to the degree of B.Sc. (Honours) Nursing.

Such a type of nursing education is a part of and an aid to the higher education of women in India. It means providing women with a scientific preparation for a professional career (or for better home life) and developing the whole individual for full living, creative thinking and citizenship responsibilities. It is hoped that it will produce nurses having that good foundation upon which experience and advanced study can safely be grounded. These Indian nurses should provide sound leadership for the nursing profession of the future. It is hoped that this course will attract students from the best families of all communities and earn for the profession the dignity and respect that can come only when Indian women of culture and education enter its ranks.

The College is located at 12, Jaswant Singh Road, New Delhi. The course of study is given below in order to draw the attention of readers and responsible leaders of opinion to encourage Indian girls to join the course. No doubt other universities will initiate such a course if the demand for it increases.

The college provides a course for the B.Sc. (Honours) Nursing of the Delhi University. The course of study extends over a period of four academic years. The Honours course includes the following subjects:—

(a) Main subject—Nursing.

(b) Two subsidiary subjects

- (i) English ;
- (ii) Elementary Science (Physics, Chemistry and Biology).

(c) Any one of the following qualifying subjects

- (i) History of Science and Scientific method ;
- (ii) World History ;
- (iii) Modern Indian History;

The minimum qualification for candidates desiring admission to the course is —

(i) The Higher Secondary Examination of the Board of Higher Secondary Education, Delhi, or any examination recognized as equivalent thereto, or the London Matriculation Examination or the Cambridge (senior) School Certificate Examination or the Oxford School Certificate Examination, or

(ii) The Qualifying Examination conducted by the University of Delhi, or

(iii) The Intermediate Examination of any Indian University incorporated by any law for the time being in force, or any examination recognized as equivalent thereto

The College Session commences on the 25th July, and application for admission should be submitted by June 30 on forms that can be obtained from the Principal.

BURRIDGE'S THEORY OF COLOR VISION

N M BASU,

PRESIDENCY COLLEGE, CALCUTTA

BURRIDGE'S theory[1] states that retinal-end organs are living rhythmical structures having a normal rate of beat which is determined by their own intrinsic forces Burridge assumes that these end organs at the periphery of the retina are unduly labile and are similar to those possessed by yellow-blue blind persons According to his theory colors either quicken or slow the rhythmical movement of these structures, warm colors, *viz*, red and yellow, quickening and cold colors, *viz*, green and blue, slowing their movements Yellow is a greater quickener than red and blue a greater slower than green The color perception is due to an alteration of the normal rhythm, and the brightness of a color is due to amplitude of movement The normal rhythm produces the sensation of grey but with an increase in the intensity of light there is an increase in amplitude of movement, resulting in the sensation of white To explain different types of color-blindness Burridge assumes that the end-organs become more stable or hard in red-green blindness, whereas they become, curiously enough, more unstable in yellow-blue blindness. Consequently, in red-green blind persons red or green cannot alter their rhythm on account of their becoming very hard or stable and in yellow-blue blind persons, yellow or blue alter their rhythm, on account of their becoming very unstable, to such an extent that their movements can no longer be perceived In the course of the development of his theory, Burridge assumes that the end-organs in cochlea, responsible for the sensation of sound, its tone and loudness, and the end-organs of retina, responsible for sensations of color and light, are rhythmically active and their functions are comparable.

[1] Burridge—*Proc. Nat Inst Sci, India, 3*, 311-335, 1937

CRITICAL EXAMINATION OF BURRIDGE'S THEORY

I Rhythmical activity of any living structure is found to be always associated with an alteration in their potential difference (due to an alteration in the state of polarization of their surfaces) leading to a discharge of action potentials (or nerve impulses) through nerve-fibres in connection therewith Sensory end-organs in the retina *viz*, rods and cones, are connected with nerve fibres, each cone being connected with one axon but several rods with one fibre[*] If there be any rhythmical activity of these organs, then by tapping off potentials from single fibres (so as to avoid any interference between potential waves travelling at different rates and different time-intervals through different fibres, such interference giving false records when potentials are tapped from a bundle of nerve-fibres, instead of from a single fibre) and amplifying them suitably it is possible to record them Granit *et al* succeeded in recording action potentials by applying micro-electrodes to different points in the retina, which would cause discharge of impulses either through one or very few optic nerve-fibres They did not get any evidence of such rhythmical activity while the eye was resting in darkness

II The sensory end-organs of the retina and their properties cannot be similar to those of the

[*] In the foveal region every cone has its own nervous connection, but a single nerve fibre has to serve nearly 200 rods

cochlea, as assumed by Dr Burridge The plan of arrangement in these two sense-organs is different In ear, the end-organs are so arranged that nerve-terminals are stimulated mechanically by being pulled in and out by hairs of hair-cells[2] They are not stimulated electrically by cochlear potentials, generated within the cochlea as the result of the distortion of non-nervous structures by sound waves In eye, the arrangement is such that the mechanical stimulation of end-organs is out of question That twilight vision or vision in dim light is caused by the bleaching of visual purple (present in rods) has been proved beyond doubt Thus, spectrophotometric absorption curves for visual purple reveal that the substance has a maximal absorption at about 500 mμ The rate of bleaching of visual purple is maximal at about this wave-length (*i e*, 500 mμ) and the energy threshold required to excite the retina is found to be minimal at about this wave-length, being of the order of 5×10^{-12} erg which is nearly equal to the quantum for green light (*viz*, 4×10^{-12}) Twilight vision is most prominent with light of this wave-length The inescapable conclusion is that visual purple is concerned with vision at low illumination, the stimulation of the nerve being effected by some product or products of bleaching reaction of visual purple The question of any rhythmical movement of these end-organs in the production of vision under these conditions does not arise at all, for the chemical mechanism mentioned above explains the facts fully Regarding color vision, the latest researches of Granit *et al* in plotting spectral sensitivity curves with wave-lengths as abscissae and the inverse value of energy necessary for threshold excitation at different wave-lengths as ordinates (the inverse value of energy is taken for the lower the value of energy for threshold excitation of a light of a particular wave-length, the greater must be its excitability) show that in the dark-adapted eye the spectral sensitivity curve thus plotted coincides with the spectrophotometric absorption curve of the visual purple with the maximum in both sets around 500, but in the light-adapted eye the maxima shift to the region of 560 mμ (Purkinje Shift) It is further revealed that two types of bands are present in these curves under conditions of light adaptation (*a*) broad absorption bands, called dominators, with maximum absorption at 560 mμ, and (*b*) narrow absorption bands, called modulators, with maximum absorption (1) between 580 mμ and 600 mμ (red), (2) between 520 mμ and 540 mμ (green) and (3) between 450 mμ and 470 mμ (blue) The interpretation is that luminosity is determined by the total number of impulses released through the influence of dominators and that color sensation is due to the interaction of modulators on dominators Visual purple is the dominator in the scotopic (dark-adapted) eye, it may also be the mother-substance of the dominators and modulators in the photopic eye (light-adapted) or a separate chromo-protein (visual yellow according to Hecht and Wald) may be the dominator in the photopic eye, the modulators being produced by changes in linkages between the protein-nucleus and the chromatophore in the chromo-protein.

It is thus evident that sensations of luminosity and colors are the outcome of photo-chemical reactions in the retina Accordingly the question of their production by variations in rhythmicity of end-organs cannot arise

III Burridge assumes that in red-green blindness, the end-organs become hard or more stable and therefore moderate stimuli like red or green cannot alter their natural rhythm and hence blindness to these colors results *First*, a person does not become blind of both red and green colors, he may be either red-blind (*i e*, protanopic) or green-blind (*i e*, deuteranopic) If any such type of blindness be due to greater stability or hardness of end-organs, it follows that neither red nor green can alter the natural rhythm, for according to the theory red has as much capacity of altering the rhythm in the positive direction, as green has in the negative direction Consequently, the red-blind would be also green-blind, and the green-blind would be also red-blind, but this is not the case Accordingly the explanation of red-green-blindness does not hold good Secondly, if in red-green blindness the end-organs become so stable that their rhythmical movement canot be altered by moderate stimuli, like red or green, it is reasonable to think that stronger stimuli than red or green, *viz*, yellow or blue can alter their rhythm, but it is not possible that they could alter their rhythm to such an extent as they would do when these organs were less stable (as for example, under normal conditions) Accordingly, yellow and blue under such conditions of stability as is assumed in red-green blindness, would not produce yellow and blue sensations which are assumed to result when a certain degree of alteration of natural rhythm of end-organs is produced These colors would rather produce sensations akin to red or green, which are believed to result when the alteration of rhythm is to a less extent. But red or green-blind persons do not confuse yellow or blue colors and see them as they are Thus Burridge's explanation of red-green blindness does not stand to reason.

IV According to Burridge yellow-blue blindness is due to lability or instability of end-organs. If a structure be unstable or labile, it is easy to understand that a strong stimulus, like yellow, will make it move too fast to be perceived ; but why should a

[2] Bayliss—Introduction to General Physiology, pp 109 and 110

slow stimulus, like blue, will make it move more slowly, instead of making it move faster than when it is more stable, as under normal conditions Then, assuming Burridge's contention to be true, *viz*, a strong stimulus makes the organs move faster than normal, and a slow stimulus makes them move more slowly than normal—a very anomalous phenomenon

Considerations like those mentioned in red-green blindness (vide III above) would lead to the conclusion that a person who is yellow-blind would be also blue-blind and *vice versa*, but this is not true Further, if yellow and blue alter the rhythm owing to extreme lability of organs to such an extent as cannot be perceived, weaker stimuli, like red and green, would alter their rhythm to a greater extent than usual, and are, therefore, likely to produce sensations akin to yellow and blue But yellow or blue-blind persons see red and green as they are Thus Burridg's explanation of yellow or blue-blindness cannot be accepted

From these considerations it is evident that Burridge's theory is a mere speculation and is the result of confused and loose thinking It is not based on facts of color-vision and cannot explain these facts It has one merit, *viz*, that it has been stated in clear, unambiguous and simple language

BENHAM'S TOP EXPERIMENT AND ITS EXPLANATION IN TERMS OF BURRIDGE'S THEORY

Benham's top is a philosophical toy invented by Benham in 1894 It was called "artificial spectrum top", but now known as Benham's top It is a circular disc divided in 2 equal parts, one white and the other black In the four quadrants of the white half, four series of arcs of concentric circles are drawn with unequal radii When the disc is turned slowly, curious color impressions are obtained If the speed is increased, the colors change When the speed is very greatly increased, colors disappear and the appearance of a grey disc containing several continuous concentric black rings is obtained. If the disc is rotated in the opposite direction, colors appear in the reverse order The description of these colors varies with different observers Bidwell and Pieron investigated this phenomenon very thoroughly Naidu's description of these colors[1] differs considerably from that of Bidwell and Pieron No satisfactory explanation has yet been given of these brilliant color effects produced by objects that are themselves colorless simply by virtue of certain sequences on the retina as to both time and space Southall, a noted Professor of Physics in the Columbia University spoke as follows in 1937:

"these color sensations are beyond our ken and no theoretical explanation can be considered satisfactory until we know more about the physiological processes in the retina itself"

Naidu suggested the following explanation.

"During the rotation of the disc black and white sectors alternate in certain proportions The result of this alternation is an alteration of the natural rhythm of the retinal sensory end-organs, as assumed by Burridge With lower speed, there is damping, but with highest speed and *with one set of arcs* there is augmentation The colours, therefore, range from violet to green"

Assuming for the present that Burridge's theory is correct (although I have shown before that this theory cannot survive critical examination), the interpretation of the phenomenon in terms of the theory is very peculiar. First, the red-color appeared with 2 sets of arcs and not with one set (*vide* Naidu's article—Table I &II), *viz*, with A, when the speed of rotation in 0·21 sec in the direction of the hands of a watch, and with D when the speed of rotation is 0·23 sec in the reverse direction The appearance of red color in 2 sets of arcs has one common peculiarity, *viz*, that when the rotation takes place in the direction of the hands of a watch, the retinal area receiving the impression of set of arcs, *A*, immediately afterwards receives the image of the black sector; again when the rotation takes place in the opposite direction, the same thing happens with the set of arcs, *D* That this consideration is of major importance in the appearance of red color, provided the rotation attains a certain order of speed, is obvious from the fact that A is violet when the disc is rotated in the reverse direction, although the velocity of movement of A is greater than that of D* It is thus obvious that speed alone is not responsible for red color

According to Burridge green and blue are slowers of the natural rhythmic movements of end-organs, but blue is a greater slower than green, whereas red and yellow are quickeners or accelerators, but yellow is a greater quickener than red If the colors produced during the rotation of Benham's top are caused by the rate of alternation of black and white sectors, *i e*, by the rate of movement, then with an increase in rate, there should be an augmentation of the natural rhythm of end-organs, leading to the appearance of the colors in the following order, *viz*, blue, green, red and yellow If it be found that with an increase in the velocity of movement the above order of appearance of colors is shown in one set of experiments, but is reversed in another set, then speed is not certainly the factor concerned in the alteration of the rhythm. I have already mentioned that with the same speed of rotation the velocity of movement of A is greater than that of B, of B greater than that of C, and so forth In table I with a speed of rotation of 0·40 sec, C is

[1] *Current Science*, 7, 275, 1938

* When a circular disc is rotated, the velocity of movement of its different parts varies according to their distance from the centre

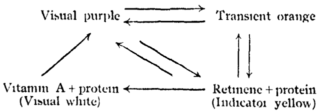
green and D blue. This is what is expected, but in table II with a speed of rotation of 0.20 sec, A is blue but B is green. This is the reverse of what is expected from the theory. I also pointed out previously that the appearance of red is more concerned with another factor than with speed. Thus Naidu's contention that Benham's top experiment supports Burridge's theory is not based on logical conclusions from his own experimental results.

Further, Fechner and Helmholtz pointed out long ago that if the eye, after resting in darkness for a long period, be stimulated by a highly luminous object for a very brief period, *i.e.*, by an instantaneous flash of light, the positive after-image that follows the withdrawal of the stimulus is apt to exhibit a succession of vivid colors, the sequence being different according to the duration and intensity of the primary *white* stimulus. According to Helmholtz the sequence is white changing quickly through greenish-blue into indigo-blue, later into violet or pink, followed by orange which is usually the last color before the positive after-image fades out. Weve[1] found the following color sequences:

Primary stimulus—*white*, sequence of color in positive after image—blue, yellow, green, red, bluish-green.

Primary stimulus—*yellow*, sequence of color in positive after-image—pale blue, yellow, green, red, bluish green.

In these cases the question of rate of alternation of sectors before the eye, altering the rhythmical movement of end-organs does not arise, yet the colors appear after stimulation of the eye by white light. Thus Burridge's theory cannot explain the appearance of these colors. An explanation of the appearance of these colors is to be sought from the researches of Granit *et al* (*vide* supra) and of Wald on the products of decomposition of visual purple, *viz.*,



[1] *Brit. Jour. Ophthal.*, 9, 627-638, 1925.

BOOK REVIEWS

Trees in Britain: wild, ornamental and economic and some relatives in other lands.—By L. J. F. Brimble. Pp. x + 352 with 8 coloured plates, photographs and drawings. Macmillan & Co., Ltd., London, 1946. Price 15s.

This book may be looked upon as the volume 2 of the author's 'Flowers in Britain' (see *Science and Culture*, January, 1946, p. 378) and is written with the same object and on the same plan as the latter. The book deals with both gymnospermous (mainly conifers) and dicotyledonous, indigenous and exotic, wild and cultivated trees in Britain.

The introductory chapters help the reader to understand the form and structure of plants with particular reference to trees, their classification and their habits and habitats. The species dealt with in the remaining chapters include ash, beech, birch, box, cedar, cherry, chestnut, cypress, elm, fig, fir, oak, pine, spruce, walnut, willow, yew and a host of others. A comparative detailed treatment of these is possible because the number of species dealt with is about 400 as a contrast to 2,000 species dealt in 'Flowers in Britain'.

Trees are important commercial commodity for the timber they yield and the Forestry Commission in Britain established in 1920, has acquired about one and a quarter million acres of land, of which half a million has already been afforested. Facts concerning the forest trees are described not merely from the botanical but also from the utilitarian point of view. The book will thus be useful to the foresters, the arboriculturists and the dendrologists.

In the absence of an up-to-date *Flora of Britain*, this book when read along with author's 'Flowers in Britain' and Hutchinson's 'Common Wild Flowers' (Pelican Books, 1945) give a fairly complete account of Britain's phanerogamic flora.

The book is an admirable production and considerably adds to Mr Brimble's reputation as author of biological books for the general reader.

The review would be incomplete without a word of praise for the beautiful coloured plates, photographs, line drawings by the talented author himself

and pencil drawings by Ven L Ragg D D, while the exhaustive indexes, both botanical and general, render it a perfect book of reference

A K G

A Text-Book of Quantitative Chemical Analysis—By A C Cumming, D Sc and S A Kay, D Sc, Ninth Edition, 1945 Oliver and Boyd, Edinburgh, Royal 8vo, p xv + 515 Price 18s 6*d* net

The usefulness of the book is evident from the nine editions it has gone through since its first publication in 1913 The book is intended for the chemical analyst working in factories and standardization laboratories, where ready and standard methods of reasonable accuracy are in constant demand

Part I is a chapter on the general principles of quantitative analysis Part II is a long but well-written chapter on volumetric analysis, describing standard methods and electrometric titrations Part III on gravimetric analysis contains general directions, typical gravimetric exercises and electrolytic methods Part IV is a short chapter on some colorimetric methods Part V on systematic analysis describes methods for the estimation of nearly sixty cations and anions, including the rarer elements Ti, V and W The three closing chapters on the analysis of simple ores and alloys, gas mixtures and water contain standard methods of procedure, ably presented

A remarkable defect of the book is the extreme paucity of references to the original literature, which one must consult in any case of difficulty or in ascertaining the degree of precision of a recommended method Oxidation-reduction potential values for Ti^{iv}—Ti^{iii} and Sn^{iv}—Sn^{ii} quoted on p 203 are incorrect Some recommended procedures, *e g* using paper-pulp to filter a solution of permanganic acid (p 117) and adding a barium chloride solution dropwise to separate sulphate from cations (p 242) are open to question Fig 15 (facing p 33) serves no apparently useful purpose, and should be discarded

J G

Pure Cultures of Algae—Their Preparation and Maintenance—By E G Pringsheim with a foreward by F E Fritsch Cambridge University Press, 1946 Price 7*s*. 6*d* net

In the 8 chapters the author has given more or less a complete resume of the practical methods he devised in the culture of the different groups of Algae mainly Chlorophyceae and Flagellates

Thus the author has made a laudable attempt to dispel from the minds of many that artificial culture of Algae results frequently in abnormal morphological forms which lead to complications with regard to the systematic position and life-history of a particular alga under investigation The importance of prolonged study of algae in the field under natural ecological environment can never be minimised, but at the same time Prof F E Fritsch rightly points out in the opening sentence to his foreward—"In many branches of biological science progress is dependent on the gradual improvement of the methods of investigation Further Dr Fritsch observed "Recognizing the diversity of ecological factors to which the organisms concerned are subjected, Pringsheim developed a more elastic method of approach and endeavoured to mould his culture technique to fit the needs of the individual alga or flagellate How great a degree of success has thus been achieved will be evident to anyone who has made use of the numerous cultures he has now at his disposal These cultures are healthy populations composed of single organisms, and in general display none of that extraordinary variability which made one feel dubious as to the value of the culture grown by the Geneva school Herein lies the value of the book"

It is admitted on all hands that the unialgal cultures and sometimes bacteria free cultures have a number of advantages—particularly in some of the specialized work of great agricultural importance as that of Dr P K De on "The Role of Blue-green Algae in Nitrogen fixation in Rice fields" (*Proc Roy Soc B* 127, 121)

"Unialgal" the author rightly states "preferably soil-and-water, cultures, preparatory to freeing the material of bacteria, have the following advantages (1) There is considerable certainty of securing growth even of single or widely scattered individuals (2) These cultures serve for identification and admit of the investigation of morphology and reproduction under the most favourable circumstances, without the possibility of confusion with other algae (3) Plentiful and healthy material for starting subcultures of all kinds is obtained (4) Time is available for the preparation of agar plates and other media, and the elimination of bacteria can be undertaken at leisure and when convenient In this way there is no risk of losing species of interest, as often happens if the original sample is kept in the laboratory for more than a day or two (5) Plating is effected with a single species and not with a mixture of different algae The separation of the purification process into two stages, the first involving the preparation of unialgal or species-pure cultures, the second that of bacteria-free or absolutely pure cultures, is very helpful. There is no doubt as to the specific identity of the colonies; hence only those which are likely to be bacteria-free need be selected, (6) Washing can be undertaken at a magnification at which, the

species could often not be certainly recognized Even flagellate stages not exceeding 12 μ in length can thus be separated from bacteria (7) One of the greatest aids in plating lies in the elimination of unwanted organisms, other than bacteria, which might spread over the surface of the agar. Such are fungal mycelia, Amoebae, Diatoms and Cyanophyceae, which often create so much trouble that the operation is abandoned as hopeless. (8) By preparatory cleaning of the algal material for inoculation the number of plates is reduced and material and time are saved " The use of cultures are of value for (1) morphological and cytological studies, (2) studies of ontogenetic development, (3) definition of species, (4) variability and mode of origin of species, (5) cellular pathology, (6) cellular physiology, (7) physiology of development, (8) physiology of nutrition, (9) physiology of metabolism, (10) physiology of irritability, especially tactic movements, (11) ecological studies, (12) biological examination of water, (13) as a food for animals under investigation In our country the application of algae culture for scientific pisciculture will prove to be of great scientific and practical value towards increasing the wealth of edible fishes in our country "Greater use should be made" writes Pringsheim, "of algal cultures for feeding small animals, since in this way various problems, as yet scarcely broached, may be solved Such problems concern the essential chemical elements, well investigated in plants, but not in animals, the mode of digestion of certain organic compounds like algal food reserves; the method of trapping and of devouring food particles "This confirms also the truth of the Chinese proverb 'Big fish eat little fish, little fish eat shrimp, shrimp eat mud"—mud is really the decomposed algae and other vegetable matters consumed by shrimp as my investigation of the gut contents of some of the fresh-water edible fishes reveals But such proverb and observations need detailed study by actual cultural experiments

It is a matter of satisfaction that Pringsheim more or less confirms the results, the writer obtained, in growing *Pandorina morum* in dilute peptone solution Good results were also obtained when the unialgal culture was made in dilute normal saline (Biswas, K —"Notes on the Organisms in the Filter of Calcutta. *Journ and Proc Asiatic Soc, Bengal* (New series), Vol. XXVI, 1930, No 4, 1932) In these two liquid media as well as in distilled tap water *Chlorella vulgaris* grew fairly well in pure culture This alga showed, however, healthier growth than in liquid media when grown in solid Agar plate and test tube. Of the Conjugatae—*Clostarium Libellula* grows and multiplies vigorously in soil and water culture with decomposed materials of fresh-water *spongilla* with which this alga is often found to live in association with each other *Scytonema mirabile*, *S. ocellatum*, *Porphyrosiphon Notarisii*, *Osillatoria Acula*, *Phormidium tenue*, *P fragile*, *Lyngbya dendrobia*, *L arboricola*, *L. aerugineo-Coerulea*, *Vaucheria* sp. and several other subaerial algae grown in sterilised bark, mud and sea sand soaked in distilled tap water within petri dishes and kept under a moist chamber, exposed to the normal north light of a covered verandah, gave exceedingly good results. Subcultures of the subaerial algae in such media can also easily be made

The book appears to be lacking in a bit detailed account of the various methods of cultures described This would handicap the beginner in tackling many genera particularly those not dealt with in the book Moreover, the various methods outlined in the book will have to be considerably modified in the investigation of the algal flora of a tropical country in the light of actual cultural experiments of the various groups of Algae of Warmer regions Cultural methods of marine algae and subaerial algae should have been treated more exhaustively

Nevertheless, it is an extremely useful treatise on such an important but by no means an easy subject I fully endorse Prof Fritsch's concluding remarks in his foreward "It is impossible to overestimate the importance of data supplied as a result of experience accumulated over many years by an expert like Pringsheim, and this volume should go far in the direction of initiating the novice into the methods of pure culture and of fostering interest in this important technique If it achieves the success which it deserves, it may well open up a new era in the intensive investigation of the many aspects of lower organisms that claim the immediate attention of biologist In many ways the study of this branch of microbiology is of outstanding economic importance quite apart from its fundamental interest in exposing the characteristics and modes of life of lower forms of plant and animal organization "

The book undoubtedly fills up a gap in our algal literature and it will prove to be invaluable to all algologists, particularly during the present time when it is difficult to procure numerous literature on the subject Therefore the list of most of these literature at the end of the book is a valuable addition

The author deserves congratulations for writing a book containing comprehensive account of almost all the important methods of algal cultures the study of which started as early as 1890 from Beijerinck and Miquel's time and continued by the author and band of other workers up to the present date. Pringsheim's 'Pure Cultures of Algae' is undoubtedly an indispensable guide to all those interested in algae and microbiology. The printing is excellent

K. B.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

THE FRUIT-PULP OF *CASSIA FISTULA* L

THE fully ripe, decorticated and de-seeded, deep brown fruit-pulp of *Cassia fistula* L has been found to contain large amounts of sugar together with small amounts of pectin and colouring-matter (*vide* Central blatt 1911, II, 1914; Maurin, Bull Sci Pharm 1922, 1917).

A more detailed examination of the pulp collected at Dacca gave the following data on the basis of the air-dry material.

Moisture and volatile matter—15.3%, ash—4.36%. Analysis of the ash gave P_2O_5—10.48, Ca—3.33, Mg—0.53, Fe—10.60, and matter is soluble in Hcl—4.7%. The rest was Na and K (by difference).

Steam distillation of the pulp gave butyrile and formic acid and their ethyl esters, the total amount being 1.86%, calculated as butyric acid. Sugar (non-reducing) in the hot water extract clarified by lead acetate was 41.86%. The presence of pectin was confirmed.

Light petroleum, acetone and rectified spirit extracted successively were 11.0, 6.1 and 57.9% of the pulp-matter. The first extract contained the above volatile acids (1.4%), their esters (0.35%) a neutral crystalline wax, m.p. 53-55°C, 2.67%, a neutral terpene and a light yellow acidic colouring-matter, together 6.5%. The last turned red with alkali and gave a brown precipitate with $FeCl_3$.

The acetone extract was also acidic and yielded on neutralization and extraction with ether more of the neutral wax (with a light green colour) and a brown insoluble acidic colouring-matter on acidifying a soluble yellow colouring matter remaining in the aqueous layer and being extracted by ether.

The alcoholic extract containing much sugar was mainly soluble in water and gave also a small amount of the neutral wax, a small amount of a yellow acidic colouring matter and organic acids giving in soluble salts with lead acetate and basic lead acetate. From these salts tartaric, citric and malic acids were isolated. Iron was present partly combined with these acids before formation of the lead salts.

Hot KOH solution extracted large amounts from the original pulp. A brown insoluble acidic precipitate thrown down on acidification was fused with KOH. Steam distillation of the acidified malt gave *pasty* for formic, acetic and isovaleric acids (in soluble zinc and silver salts).

Further work on the nature of the colouring matters is in progress.

M. A. KARIM
S. S. GUHA SIRCAR

Chemical Laboratory,
Dacca Intermediate College,
Dacca University,
Ramna, Dacca, 8-6-1946

INTERNAL PROLIFERATION IN *CARICA PAPAYA* L

THE *Carica papaya* L. is a very well known small tree with a crown of leaves at the top. The berry is edible. It is very variable under cultivation. The Ranchi variety is noted for the fruit being very large and is grown in different parts of the Province (Bihar).

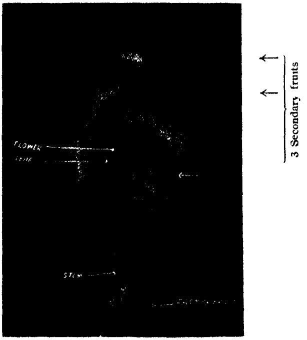


FIG. 1. Secondary fruits and flower inside a papaya fruit

Recently an unusually interesting teratological phenomenon was discovered inside a ripe fruit on

cutting it open A miniature plant bearing three secondary fruits and male flowers were found within the seed cavity (Fig I—after removing the pulp) Externally the mother fruit was quite normal

The three fruits are of a very light cream colour The expanded bases of the two carpels have practically fused together by abnormal growth during development inside the mother fruit They occur on a stout axis Sections show that there is only one chamber in each fruit No mature seeds are found There are a few rudimentary ovules on placental surface The style is absent but the stigma is dominant with spongy surface.

At the upper end of the axis there were three male flowers, out of which 2 broke out One is already shown in the figure (Fig I) The male flower is of the normal type possessing 10 unequal stamens The anthers are yellow and the filaments smooth

Below the male flowers are borne the foliage type of leaves crowded together One of them has developed sufficiently and is visible at the top It is colorless and palmately lobed with cylindrical petiole (Fig. 2).

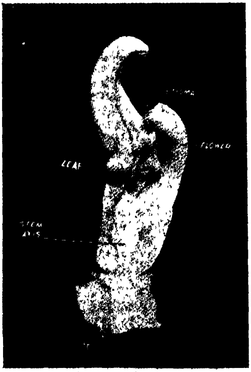


FIG. 2. Proliferation of stem axis bearing leaves, flowers and secondary fruits inside a a papaya fruit

In the specimen in question it appears that the thalamus behaves as shoot. The thalamus forms a stout axis in continuation with the pedicel and extends inside the chamber of the mother fruit (Fig 2). The three fruits which have developed from the female flowers are situated at the base of the axis in acropetal succession, and the male flowers at the apex

Bergman[1], recorded five small secondary fruits within a papaya fruit. Sayeeduddin and Bari[2] similarly recorded small fruits within big fruits of *Carica papaya*

Cheema (1924) has observed that papaya can develop fruits without pollination which are also seedless Burns (1920) has reported that parthenocarpy exists to a very large extent in this crop

So far as I am aware of, reversionary phenomenon as observed in this specimen, showing both vegetative and reproductive median proliferation has not been recorded in *Carica papaya*

A SATTAR KHAN

Biological Department,
Science College,
Patna, 3-7-1946

[1] Bergman, H F, *Bot Gaz*, 72, 97-101, 1921
[2] Sayeeduddin, M and Bari, A, *Current Science*, 4, 740-741, 1936

ABSORPTION OF MOISTURE BY THE PLANT MATERIALS

DR RAMDAS and his collaborators[1] had recently found that the plant materials such as cerials and their leaves have maximum moisture content at the minimum temperature epoch and minimum moisture content at the maximum temperature epoch In order to verify his conclusions and study the subject further, the author studied the absorption powers of some plant materials such as wood, leaves, and seeds of some plants of the hills as well as the plains (especially the chillies) with the help of his specially designed apparatus[2] for study of absorption of moisture by soils He (the author) has also studied the effects of their age, physical condition, time of exposure and relative humidity on their absorption of moisture from the surrounding atmosphere

It has been observed that the amount of moisture absorbed by the plant materials varies according to the nature of the material and locality of its growth The plant materials of places having higher humidity are more hygroscopic than those of places having less humidity. The leaves are more hygroscopic than the wood of the same plant and the seasoned wood has the minimum power of absorption. The powder of any plant material is more hygroscopic than the plant material of the same plant in natural form.

The plant materials behave like soils but have higher absorption powers than the soils The amount of absorption increases with the increase of relative humidity of the surrounding air But the rate of absorption decreases with time It is higher in the beginning than at the end

The age of the plant materials reduces their absorption power The older the plant material is, the less is its absorption power

It has been further observed that when the finely powdered dry plant materials produced by crushing the young plants are mixed with soil, they increase the absorption power of those soils It is possible that this process may reduce the necessity of frequent irrigation and may also help to some extent the dry farming

The results are interesting and some of them confirm Dr Ramdas's conclusions The details of this paper shall appear elsewhere in due course of time

The author takes this opportunity to thank His Highness' Government, Patiala, for providing facilities to carry out this work in the Physics Research Laboratory, Mahendra College, Patiala

L D Mahajan

Physics Research Laboratory,
Mahendra College,
Patiala, 5-7-1946

[1] L A Ramdas, A K Malik, *Cur Sci*, 6, 1933, A K Malik, *Ind Jour Agri Sc*, 9, part iii, 1939
[2] L D Mahajan, *Ind Jour Phys*, 19, part vi, 441-450, 1940

THE GEOLOGICAL SURVEY OF INDIA

My attention has been drawn to a letter in your February issue (vol 10, No 8, 1946, Pp 445-446) by Sir Lewis L. Fermor on the Geological Survey of India, and in which certain statements appear in need of clarification with facts as distinct from personal opinions

There are three details which are of special interest in the above letter which I believe should be placed beyond dispute. These are that the Geological Survey of India was initiated as a Department with appointment of Mr David Hiram Williams in December, 1845, when he sailed for India, or on the 5th February, 1846, when he reported for duty in Calcutta ; there is also the question of the taking of Mining and Metallurgical Specialists from the Geological Survey for the Inspectorate of the Department of Mines in India ; and lastly the question of the right exercised by the Government of India in promoting officers to the post of Director, even over the next senior.

In my Presidential Address to the Mining and Geological Institute of India, in 1936, I had reviewed the evolution of the Geological Survey of India (*Transactions, Min Geol Inst, India*, Vol. XXXI, pages 14 to 37, 1936), and on page 20 I referred to the story that Dr T Oldham found very little to build upon when he took over in the Surveyor General's Office, and I said that that was not the whole truth because it was certain that Dr John McClelland must have been in possession of valuable information even if it was not handed over to Dr Oldham Since I gave my address I have traced the correspondence in the Secretariat of the Government of Bengal

It is too long to include in this letter, but I will give a brief resume of it, and I have placed copies in the custody of the Department of Labour, Government of India, a year ago A Coal Committee had been formed in Lord Auckland's day and was in being from 1837 to 1846 with Dr John McClelland as its very energetic and able Secretary It had been found insufficient to bring out miners from the United Kingdom to develop coal mines in India, because they were handicapped by lack of geological data on the coal formation, and so recommendations had been made in 1843 for a geological survey to be carried out on the most scientific lines possible

Previous to the letter from the Government of India to the Hon'ble Court of Directors of the East India Company (dated 14th October, 1843, No 13 of 1843, Home Department, Marine) there had been correspondence between the Coal Committee and the Government of Bengal on this question (16th August, 1843) and before that between Dr McClelland and Charles Lyell Esq (10th February, 1841), and R I Murchison Esq (22nd September, 1842), and again from Charles Lyell Esq (10th May, 1843), and then from the Government of Bengal to the Government of India (No 2091, dated the 4th September, 1843, P. W Department, Marine Branch, Proceedings 81, 82, 83 of the 14th September, 1843)

The Despatch from the Hon'ble Directors of the East India Company, dated London the 23rd December, 1845, reads as follows concerning the appointment of David Hiram Williams :—

(True Copy)

Marine Department
No. 8 of 1845.

Our Governor General in Council

Para. 1 With reference to your letter No 13 dated 14th October 1843 we have to inform you that we engaged Mr D H Williams to proceed to India for the purpose of making a Geological Survey of those districts in which Coal Fields are situated, with a view of obtaining accurate information respecting the resources possessed by that country for the production of Coal and determining in what manner they may best be turned to account.

2 Mr Williams has been strongly recommended to us by Sir Henry De la Beche, Director General of the Geological Survey of the United Kingdom under whom Mr Williams has been for several years employed Sir Henry informs us that he has surveyed many of the Coalfields in Wales and in the West of England and has executed very valuable maps and sections relating to them He also represents him as having been in early life engaged in the working of Collieries and as being perfectly qualified to examine the Coal districts of India, either geologically, or practically as well as to superintend Coal works

3 These high testimonials leave no doubt of the fitness of Mr Williams for the important duty which it is proposed to confide to him, and we trust that his labours will have the effect of ensuring success to such mining operations as Government may think proper to undertake and of encouraging private speculators to embark in similar attempts

4 Mr Williams left England with the mail of the 20th of the present month (Decr) and will proceed to Calcutta to place himself under the orders of your Government The period of his engagement is limited to five years He is bound to serve in any part of the East India Company's Territories to which you may direct him

5 We have agreed to allow him a salary of £800 a year to commence from the date of his arrival in India exclusive of such travelling allowance as you may think reasonable, and we have also granted him £200 in aid of his outfit and passage to India, and have guaranteed him the like sum for his return to this country on the expiration of his period of service He has also been furnished with a set of instruments such as he is likely to require in India, in order that he may not be prevented from entering immediately on his duties These instruments (a list of which is transmitted) are similar to those used in the Geological Survey of Great Britain and have been selected by Sir Henry De la Beche

6 One of the parts of the Deed of Covenant entered into by Mr Williams is forwarded in the packet for your information and guidance

We are etc

Sd/- Henry Willcock, I W Hogg, W B Bayley, Jus Masterman, Russell Ellice, Hy Alexander, W Austell, W L Melville, I L Lushington, F Warden, John C Whiteman, M I Smith, A Galloway, Robt Campbell

London,
23rd Decr , 1845

(True copy) G A Bushby, Secy to the Govt of India

Mr Williams reported his arrival in Calcutta on the 4th February, 1846, in a letter dated next day from Spences Hotel

(True copy)

Spences Hotel
Calcutta
5th Feby , 1846

Sir,

I have the honor to inform you of my arrival in this country as Geologist appointed by the Court of Directors of the Honourable the East India Company to investigate the coal districts of India

I have the honor to be,
Sir,
Your very obedient & humble servant,
Sd/- D H Williams

F. I Halliday
&c. &c. &c.

Mr Williams took the field almost at once, and had already examined a great area when he wrote on the 31st March, 1846, from his camp at Raniganj (see para 2) ". that 12 separate seams of coal have been identified in the vicinity of Chinacoory 20 miles from here this and other indications lead me to expect to find this coalfield to be developed on a very large scale " His seasons report was dated the 10th August, 1846, Spences Hotel, Calcutta, and is of considerable interest (para 7) refers to two groups of seams of coal -10 with 78 feet of coal around Raniganj and 14 with 62 feet of coal near Taldanga, or 24 seams with 140 feet of coal , (para 8) refers to the discovery of the Jharia coalfield as he states the occurrence of coal near *Induhghur* 4 miles south of the Fitcoory Bungalow , (para 11) deals with the importance of railway communication with the coalfield , (para 13) deals with his objection to the extracting of coal from outcropping positions On May 3rd 1847, Williams had discovered the coking coal at Taldanga

After Williams death from jungle fever in 1848 Dr McClelland carried on and signed himself as "Offg Supdt Geological Survey of India" (letter dated 20th Dec , 1848) He also submitted the official "Report on the Geological Survey of India for 1848-49" McClelland asked to be relieved and refers to the need for a successor to Williams, when it was agreed that the Department should be taken over by the Deputy Surveyor General, Capt Thuillier R E (later Col Thuillier, Kt , F R S) (letters of 23rd March and 1st April, 1850) After the transfer was effected (30th April, 1850) Williams' senior assistant, R G Haddon, was designated "Asst Geol Supdt " in orders issued to him for work This will explain how Dr T Oldham (who was appointed on similar terms and also on a 5 year basis) went to the Surveyor General's office to collect his staff and gear However, the terms of Dr Oldham's engagement and 5 year renewals are in his personal file in the Geological Survey Office, Calcutta

Two letters addressed to Dr Oldham in 1851, may have escaped notice The former is as follows

(True copy)

No 290 dated 21st March
from India, Home Dept

From

W Grey, Esq , Under Secy to the Govt of India

To

T Oldham, Esq , Geological Surveyor

Sir,

In reply to your letter dated the 5th instant reporting your arrival and soliciting instructions as to further proceedings, I am directed to acquaint you that the President

in Council has been pleased to place your services for the present at the disposal of the Government of Bengal

Sd/- Illegible

Council Chambers
the 21st March, 1851

The other letter was as follows —

(True copy)

No 189 dated Fort William, the 24th March, 1851

From
The Secretary to the Government of Bengal,

To
Professor T Oldham

Sir,

I am directed by the Deputy Governor of Bengal to transmit herewith, for your information, the accompanying copy of a letter from the Under Secretary to the Government of India in the Home Department, No 291 dated the 21st instant, and to request you will proceed to the Sylhet Hills, with the view of prosecuting your researches there until the season will permit of your examining the valley of the Damoodah You will address your reports to this office

2 At the time of the death of Mr Williams the Establishment of your office was as following —

Mr Haddon	Rs 350
Mr Jones	Rs 350
A sub-asst surgeon	Rs 100
A writer & interpreter	Rs 50
	Rs 850

3 Before Dr McClelland made over charge of the office the Establishment was as follows

Mr Haddon	Rs 350
Mr Theobald	Rs 100
Mr Gomes	Rs 100
	Rs 550

The persons still borne upon your Establishment are

Mr Haddon	Rs 350
Mr Gomes	Rs 100
	Rs 450

4 Mr Haddon and Mr Gomes are at present on detailed duty at Purneah But on your intimating to His Honor that their services will be required by you in your researches in the Sylhet Hills, they will be directed to join at Sylhet or Cherra forthwith

5 You are requested to report upon the establishment you may think necessary to employ

I have the honor to be,
Sir,
Your most obedient servant,
Sd/- W Grant
Secretary to the Govt of Bengal

I think the above letters, which have not previously been published to my knowledge (and which I appear to have been the first to see since the Geological Survey was formed on the 5th February, 1846, among the subsequent officers of the Geological Survey of India), elucidate the question of the date when the Department was formed. Indeed I would add that when Dr Oldham's services were re-engaged, for 5 years from 1856 he was instructed to submit regular reports and to plan the work ahead This had been done by Mr Williams and had enabled Dr McClelland to carry on while Williams' successor was being secured The 5 year agreement was continued throughout Dr Oldham's service His pay of Rs 888/- was increased to Rs 1,100/- in 1856 and to Rs 1,250/- in 1861, and so on with each re-engagement

As regards the Mining and Metallurgical Specialists on the Geological Survey of India, up to the time that Sir Lewis L Fermor joined in 1902, the list is as follows, not forgetting D H Williams (vide para 2 of the letter from the Court of Directors of the Honourable East India Company, dated the 23rd December, 1845, to our Governor General in Council) —

- Mark Fryar, Coal Mining Specialist, joined 1st May, 1868 and died in November, 1875 ,
- William Anderson, Specialist in Mining and Metallurgy, joined in October, 1894, but resigned in September, 1896 ,
- James Grundy, Inspector of Mines, joined in 1894 and was included in the Bureau of Mines Inspection in 1902 when the Mines Department began ,
- George Frederick Reader, Coal Mining Specialist, joined in October, 1899, and died in March, 1901 ,
- George Alfred Stonier, joined in October, 1899, became Chief of the Bureau of Mines Inspection ,
- Frederick Henry Hatch, Gold Mining Specialist, joined in 1900 and resigned in March, 1901 ,
- Robert Rowell Simpson, Coal Mining Specialist, joined in 1901 but did not transfer to the Mines Department until 1906 ,
- James Malcolm Maclaren, Mining Specialist, joined in July 1902, but resigned in October, 1906

The lack of Mining and Metallurgical Specialists on the staff of the Geological Survey of India has caused many of the more technical reports of the Department to appear immature to the technical public, and has prevented the Department from being as practical as it should be It was to "Show the Way" that the Utilization Branch was instituted, and the principle is that of para 3 of the letter of the 23rd December, 1845 relating to Williams' appointment, particularly the words ". and we trust that his labours will have the effect of ensuring success to such mining operations as Government may think proper to undertake and of encouraging private speculators to embark in similar attempts." The Government of India thought fit to discontinue the

Utilization Branch after I retired and has thus allowed of the possibility of the Department drifting towards an academic atmosphere

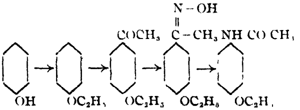
And lastly the subject of Government exercising the right to supersede senior officers in promotions to the post of Director There have been several such cases in the Geological Survey of India T H. Holland went over R D Oldham in 1902 when C L Griesbach retired although Oldham was a first rate officer H H Hayden went over C S Middlemiss when Holland retired in 1910, and no one can deny Middlemiss' great ability E H Pascoe went over L L Fermor when Hayden retired in 1920, and Fermor's worth was recognized when he succeeded Pascoe on the latter's retirement in 1932 After my service of 32 years I can say quite honestly that questions of promotion are based on efficiency and energy and administrative ability, and have never, to my knowledge, been influenced by matters of race or creed However, we are now concerned with the future and the fact that the Geological Survey of India should be expanded enormously and operate in conjunction with an organization like the Bureau of Mines in Canada or re-establish and enlarge a Utilization Branch to carry out the principle on which the Geological Survey of India was initiated when D H Williams was appointed

CYRIL S FOX

Calcutta, 7-7-1946

A NEW METHOD OF SYNTHESIZING PHENACETIN AND ALLIED COMPOUNDS

PHENACETIN, the well-known antipyretic drug, and the allied compounds, methacetin and 1-acetamino-4-methoxynaphthalene, have been synthesized by a new method which is promising as a possible industrial method as well The scheme of synthesis is essentially as follows and is based on the fact that acetophenone oxime is converted to acetanilide under the influence of phosphorus pentachloride or sulphuric acid [1]



I *Phenacetin*—An ether solution of *p*-acetyl phenetole oxime (m.p. 125°, reported for the first time) was treated in the cold with phosphorus pentachloride for half-an-hour. The residue after removal of ether was treated with ice cold water and the precipitated phenacetin was collected and crystallized from alcohol, m p. 137-138°[2] undepressed on admixture with a sample of phenacetin prepared by acetylating phenetidine, yield 80 per cent

II. *Methacetin*—When an ether solution of *p*-acetylanisole oxime[1] was treated with phosphorus pentachloride in the manner detailed above, the oxime underwent rearrangement to methacetin, m p 127° undepressed on admixture with methacetin prepared by acetylating anisidine, yield 75-85 per cent

III. *1-Acetamino-4-methoxynaphthalene*—1-Acetyl-4-naphtholmethyl-ether oxime (m p 135°, reported for the first time) when treated with phosphorus pentachloride as in I underwent rearrangement to 1-acetamino-4-methoxynaphthalene (m p 186-187°), yield 55-60 per cent The new method involves a fewer number of steps and avoids the costly processes of reduction and acetylation

The author's grateful thanks are due to Prof P C Guha, D Sc, F N I, for the interest he evinced in the present work

S SWAMINATHAN

Organic Chemistry Laboratories,
Dept of Pure and Applied Chemistry,
Indian Institute of Science, Bangalore

8-7-1946

[1] *Ber*, *20*, 1509, 1887, *Rec trav Chim*, *24*, 372, 1905
[2] *Ber*, *35*, 111, 1902
[3] *Ber*, *58*, 41, 1925

THE PATCH NUMBER PROBLEM

IN the theory of sample surveys, we have to distinguish between patterned and random space distributions One criterion proposed by P C Mahalanobis for making this distinction is to compare the observed patch number with the number to be expected on the null hypothesis, that the space distribution is random

The mathematical problem arising here can in its simplest form be formulated in the following way Consider the system of n^2 small squares or quads formed by dividing a square ABCD into n strips parallel to AB, and n strips parallel to A D Let there be two colours say 'black' and 'white', and let p be the chance for any quad to be black, and q the chance for it to be white, $(p+q=1)$

A 'black patch' may be defined to be a system of black quads any two of which may be joined by a chain of black quads, two consecutive members of a chain touching along a side We shall define a 'white patch' in the same manner, except that contact at a corner will also be recognized A white patch lying completely inside a black patch may be said to be 'embedded' in it

I have proved the following result in this connection If

$X =$ (the number of black patches) $-$ (the number of embedded white patches)

$$E(X) = p + 2(n-1)\ pq + (n-1)^2\ (pq^2 - p^2q)$$

This result has been verified by an extensive series of model sampling experiments, carried on in the Statistical Laboratory, Calcutta The variance of X, has also been experimentally studied

These mathematical and experimental results were referred to by Prof P C Mahalanobis at two lectures delivered in the Statistics Department of the Columbia University, and in the Mathematics Department of the Harvard University, in May 1946

R C Bose

Dept of Statistics,
Calcutta University,
Calcutta, 25-7-1946.

PHARMACOGNOSTIC STUDIES ON INDIAN IPECACUANHA

The well known drug 'emetine' which is a specific remedy for amoebic dysentery, is obtained from the roots of the plant *Cephaelis ipecacuanha* (Brot) A Rich (=*Psychotria ipecacuanha* Stokes) The plant is a small shrub indigenous to Brazil and is cultivated there [1] It is also cultivated in Selangor in Federated Malaya States [2] In India, it is cultivated to a small extent in Bengal at Mungpoo in the Darjeeling District

The present study was undertaken to determine the particular age of the plant when the alkaloid content reaches its maximum limit for the purpose of ascertaining the proper time of collection The materials were obtained from Mungpoo where it is cultivated under Government supervision along with Cinchona and 1-5 year old plants were subjected to investigation

The diagnostic macroscopical and microscopical characters of 1-4 years roots have been previously described [3] The roots from 5-year old plants are alike those of 4-year old roots except that the cracks are a little more prominent and that some of the thin rootlets are found to have withered The output of total amount of roots per plant is stated in the following table

TABLE I

Age of the plant	Total amount of roots per plant (Dry wt)	Average weight of roots per plant (Dry wt)
1 year	2 021 to 4 952 gms	3 5 gms
2 years	9 15 to 17 425 ,,	13 28 ,,
3 ,,	20 145 to 24 785 ,,	22 46 ,,
4 ,,	18 85 to 25 43 ,,	22 20 ,,
5 ,,	13 84 to 18 76 ,,	16 35 ,,

The analytical results of the roots presenting data about the percentages of total and non-phenolic alkaloids is given in the following table

TABLE II

Sample No & Age	Total alkaloids % (B P Add VI—not less than 2%)	Non-phenolic alkaloids % (B P Add VI—not less than 1 10%)	% Ash (B P Add VI—not more than 5%)	Acid insoluble ash (B P Add VI—not more than 2%)
I (One year)	1 45	1 18	2 89	Within limit
II (Two years)	1 70	1 21	2 00	do
III (Three ,,)	2 33	1 40	2 25	do
IV (Four ,,)	2 14	1 21	1 68	do
V (Five ,,)	2 45	1 30	Within limit	do

It will be observed from the above data that the total and the non-phenolic alkaloids, both reach the maximum in plants of 3 years age It is therefore feasible that when the non-phenolic alkaloid content is nearly the same in the third and fourth year the crop should be harvested from 3 years old plants with better advantage It is further to be noted that B P Add VI describes that Ipecacuanha root should contain not less than 2 per cent of the total alkaloids and not less than 55 per cent of these calculated as emetine From the above results it is found that as regards the total alkaloid content the roots of 3, 4 and 5 years old plants conform to the limit. As regards ash, which according to B P Add VI should not be more than 5 per cent and the acid insoluble ash which should not exceed 2 per cent, the Indian samples of roots are within standard In point of non-phenolic alkaloid content, Sample III is up to the standard and Samples IV and V are in close agreement The yield of total alkaloids appears to be enhanced in the 5th year although the non-phenolic alkaloid as percentage of the total alkaloids somewhat diminishes It is to be noticed that true Brazilian roots contain up to 2 5 per cent of total alkaloids of which about 70 per cent is said to be emetine and it is observed here that the percentage of total alkaloids in Indian roots grown at Mungpoo is less than that obtained from 2½ years old plants grown at Serdang in the Federated Malaya States. It is therefore worthwhile to carry on further experiments by applying recent agricultural methods to improve the cultivation of this very important medicinal plant with a view to get a better yield of alkaloids.

We are indebted to Messrs Bengal Immunity Co., Ltd , for their generous grant to carry on this work, to Mr S C Sen, B.A (Cant.), B.Sc. (Cal), A.M I. Chem E , Principal Quinine Officer, Government of India for his kindness in supplying us the

samples of roots, and to Dr B. Mukerji, D Sc, M D, F N.I, Director, Biochemical Standardization Laboratory, Calcutta, and to Mr S Mukherji, M Sc, of Messrs Bengal Immunity Co Ltd., for their kind help in analyzing the samples of roots

The details of the paper will be published elsewhere

S N BAL
S C DATTA

Pharmacognosy Research Laboratory,
Industrial Section, Indian Museum,
Calcutta, 8-8-1946

[1] S N Bal, An outline of pharmacopoeial drugs of vegetable origin

[2] S N Bal, Ipecacuanha, Ind Jour Phar, 2, No 1, 1940

[3] S N Bal and S C Datta, Pharmacognostic studies of Ipecacuanha, SCIENCE AND CULTURE, 10, 448, 1944-45

CHAKSINE

Siddiqui and Ahmad[1] isolated an alkaloid from the seeds of *Cassia Absus* Linn and assigned a formula $C_{12}H_{21}O_2N_3$ for it This formulation was criticized by Kapur, Gaind, Narang and Ray[2] who conclusively demonstrated that the formula should be amended to $C_{11}H_{21}O_3N_3$ for chaksinium hydroxide (chaksine is a quarternary base) However, Siddiqui and Ahmad[3] strongly opposed this view Recently Puri, Sharma and Siddiqui[4] have shown inclination to accept the formula of Ray *et al* We hope that in their next publication they will completely adopt the $C_{11}H_{21}O_3N_3$ formula.

These authors describe the benzoylation of chaksine carbonate This experiment was performed by us four years ago but in view of the fact that 2 or 3 products were isolated from this simple reaction, we could not rely on this result and hence had not described it Besides, we have already expressed our views about these bicarbonates We have now prepared the platinochloride of the chaksinium chloride described by us, whence found M W for chaksinium ion, 224 5 (calc for $C_{11}H_{20}O_2N_3^+$, M W = 226)

Chaksine has no methoxy or N-methyl groups The base is monacid and quarternary The nitrate of chaksine (chaksinium nitrate) gives with strong sulphuric acid a nitro base. The transformation is reminiscent of the urea nitrate⟶nitro urea transformation The action of nitrous acid on chaksine chloride gives a base (Kapur, Gaind, Narang and Ray)[2] which has now been proved to be $C_9H_{17}O_4N_3$ It will be seen that there is an extrusion of two carbon atoms in the reaction. Its double platinochloride was analyzed and its M.W was found to be 227 5 whilst $C_9H_{11}O_7N_3$ requires 231. The substance has a NO grouping as it gave Libermann reaction

The foregoing substance was reduced with $SnCl_2$ and gave a base (isolated as sulphate) which is under investigation It gave an acetyl derivative, m p. 197°—198° (uncorrected)

Chaksinium sulphate (2g) suspended in water (40 c c) was heated and was then treated with $KMnO_4$ solution (0 45g in 40 c c water and dil H_2SO_4 10 c c of 18 4 per cent) for an hour After removal of residue, the filtrate was concentrated and gave a deposit of silky needles of the sulphate of a base, m p 303° (uncorrected) after repeated crystallization from hot water The sulphate was converted into the platinochloride via the chloride and analyzed, found M W 244 1, $C_{11}H_{20}O_2N_3^+(O)$ requires M W 242

Chaksinium salts give bromoform with sodium hypobromite, and liberate ammonia when heated with baryte solution On strong oxidation with $KMnO_4$ solution, a mixture of acids results from which after esterification, ethyl adipate was isolated

Further investigation is in progress

M L AGGARWAL
J N RAY
D C SEN

Directorate General of
Industries and Supplies,
New Delhi, 15-8-1946

[1] Siddiqui, S and Ahmad, Z, Proc Ind Acad Sci, 2, 421, 1935

[2] Kapur, Gaind, Narang and Ray, J Ind Chem Soc, 17, 281, 1940

[3] Siddiqui and Ahmad, J Ind Chem Soc, 18, 589, 1941

[4] Puri, Sharma, Siddiqui, J Board of Sci & Ind Research, 4, 701, 1946

NOCTURNAL VARIATIONS OF THE HEIGHTS OF THE LAYERS OF MAXIMUM IONISATION OF REGIONS E AND F

IONOSPHERIC observations show that after nightfall, when the ionising solar ultraviolet rays are withdrawn, the electron densities of the Regions E and F decrease. But, while with the advance of night, the height of the layer of maximum density of Region E remains fairly constant, that of Region F increases

It is the purpose of this note to show that the origin of this difference in the behaviour can be traced to the different laws of disappearance of free electrons operative in the two regions While in Region E the rate of disappearance of electrons[1, 2] is given by

$$\frac{dN_{h,t}}{dt} = -\left(\lambda\alpha_i\right)N_{h,t}^2 \quad \ldots \qquad (1)$$

that of Region F is given by[3]

$$\frac{dN_{h,t}}{dt} = -\beta N_{h,t}n, \qquad (2)$$

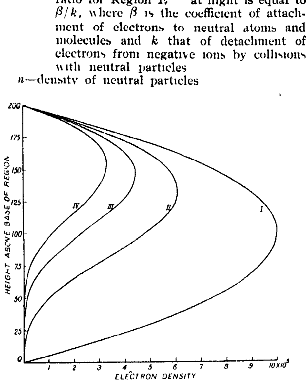
where,

$N_{h,t}$—electron (or positive ion) density at height h above the base of the region at time t,

α_i—coefficient of mutual neutralisation of positive and negative ions,

λ—ratio of negative ion to electron density This ratio for Region E[1, 2] at night is equal to β/k, where β is the coefficient of attachment of electrons to neutral atoms and molecules and k that of detachment of electrons from negative ions by collisions with neutral particles

n—density of neutral particles



Illustrating the distributions of the electron density of Region F at different hours after the withdrawal of solar rays Curves I, II, III and IV are for $t=0$, 3, 6 and 9 hrs respectively It will be noticed that the height of the layer of maximum electron density rises with progress of night

To show how the first law allows the height of layer of maximum electron density to remain constant and the second law pushes up the same, we start by assuming (after Chapman[4]) that the distribution of electron density with height is of parabolic form, namely

$$N_h = N_{2H}\left\{1 - \frac{(h-2H)^2}{4H^2}\right\}, \qquad (3)$$

where, H is the scale height of the region and the level of maximum density is at a height $2H$ above the base of the region

Thus, for Region F we may write after integrating (1)

$$N_{h,t} = \frac{N_{h,0}}{1+(\lambda\alpha_t)N_{h,0}t} = \frac{\left\{1-\frac{(h-2H)^2}{4H^2}\right\}N_{2H,0}}{1+(\lambda\alpha_t)\left\{1-\frac{(h-2H)^2}{4H^2}\right\}N_{2H,0}t} \qquad (4)$$

From this relation it is easily seen that the density at any height decreases with time and the distribution of electron density is altered from the original parabolic form The height of maximum density, however, does not alter with time and is at the level $2H$ above the base of the region as it was initially

For Region F also assuming a parabolic distribution of electron density with height, we have by integrating (2)

$$N_{h,t} = N_{2H,0}\left\{1-\frac{(h-2H)^2}{4H^2}\right\} exp(-\beta n t) \qquad (5)$$

Now, the variation of atmospheric density (n) with height (assuming constant temperature) is given by

$$n = n_0 \; exp(-h/H),$$

where n_0 is the density at the base of the region. Eq (5) may therefore be written as

$$N_{h,t} = N_{2H,0}\left\{1-\frac{(h-2H)^2}{4H^2}\right\} exp(-\beta t n_0 e^{-h/H}). \qquad (6)$$

From this relation it is seen that due to the last factor on the right hand side, the distribution is altered from its parabolic form At a particular height in the region, the electron density decreases exponentially with time In this case, however, it will be seen from the curves in the figure that the height of the layer of maximum electron density does not remain constant, but rises with time The curves are drawn depicting the distributions of electron density of Region F at different hours after the withdrawal of the rays The following representative values are assumed in the calculation—

electron density in region of maximum ionisation at nightfall	10^6 per c c
scale height	50 km
density of neutral particles at the base of Region F	5×10^{11} per c c
coefficient of attachment of electrons to neutral atoms and molecules	10^{-15} cm ^{3}/sec

The work described in the note was carried out while I was enjoying an Adair, Dutt Research Scholarship of the Indian Science News Association and I have much pleasure in thanking the Association for granting me the same.

I thank Prof S K Mitra for helpful discussions

S. N. GHOSH

Ionosphere Laboratory,
University College of Science,
92, Upper Circular Road,
Calcutta, 30-8-1946

[1] Appleton, E V and Sayers, J, *Union Radio Scient Int.*, 78, 272, 1938.
[2] Bates, D R, Buckingham, R. A, Massey, H S W and Unwin, J J, *Proc. Roy Soc A*, 170, 322, 1938.
[3] Ghosh, S N, *Proc Nat. Inst Sci. (India)*, 10, 333, 1943.
[4] Chapman, S, *Proc. Phys Soc*, 43, 26 and 483, 1931

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. NOVEMBER, 1946 No. 5

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

THROUGHOUT the month of November, Paris will be the venue of the General Conference and of a series of educational, scientific and cultural demonstrations of the United Nations Educational, Scientific and Cultural Organization (UNESCO) Discussions on the highest intellectual plane on problems and issues confronting mankind and the civilization and on the progress of education and the methods of teaching, displays of technical discoveries and their application, displays on the development of architecture, show of documentary, educational, scientific and feature films, exhibitions of paintings, concerts of modern music and drama festivals etc will characterize the celebration of the UNESCO Month, in which will join many celebrities in arts, sciences and education and leaders of thought and culture, as representatives of the nations of the world The air of Paris so frequently fouled by endless political and economic squabbles and disputes will blow refreshingly for the first time in many years, as these workers in education and in sciences and arts, whose activities have always transcended national boundaries, meet to discuss and rebuild the defences of peace in the minds of men, where wars originate

The United Nations Educational, Scientific and Cultural Organization, whose constitution was drafted in November, 1945 at a Conference in London, in which representatives of 44 nations* and of a number of international organizations participated, provides the future permanent international framework for co-operation in the field of education, science and culture It is a happy augury that along with food and agriculture, relief and rehabilitation, labour, health, bank and currency, aviation, etc , for each of which international organization has been set up, education, science and culture have also formed subject for international activity in a common effort to build a lasting peace The considerations and a common realization of the needs of mankind which have led to the unanimous decision in favour of establishing a permanent organization for promotion of international understanding in education, science and culture have found expression in the speeches of all who attended the Conference, and we cannot do better than reproduce extracts from some of their speeches here

Speaking on behalf of India, Rajkumari Amrit Kaur said

"Culture and civilization stand today at the brink of disaster. In a world dominated by power politics, rent asunder by mutual suspicions and jealousies, still bent on the exploitation of weaker peoples, each country solicitous of its own freedom but indifferent to that of others, it is, I believe, educational and cultural forces that will, if directed in right channels, save humanity There is need, urgent need, of educating primarily our children, and our youth, but also those of us who belong to an older generation, so to order our personal and collective lives, so to plan the world that greed and desire for domination may cease, for they, surely, are the root causes of war The countries taking part in this Conference must be honestly and sincerely prepared to eschew in every field of activity what is undemocratic, illiberal, totalitarian and imperialistic There can be no true freedom and consequently no genuine culture in a world which is half bond and half free, half fed and half starved, where exploitation and social injustices flourish side by side with pious expressions of good intentions and high sounding policies

"Geographical barriers may have been conquered, but oceans of hate and misunderstanding still divide

* India was represented in the persons of
Rajkumari Amrit Kaur,
Dr Zakir Husain,
Dr Amarnath Jha,
Dr T Quayle,
Mr K G. Saiyidain,
Dr (now Sir) John Sargent,

us If education is to play the part it should in the refashioning of the world, it must itself be refashioned No longer must our children be taught to think in terms only of the glory of their own country, they must think of their country as being no more than a unit in and dedicated to the service of the larger whole of a world State The precious heritage of freedom must be for every race, however backward they may be held to be in the matter of educational or industrial development There must be recognition of the common humanity of all, no barriers of race or creed may divide man from man The stories of the material destruction caused in the war will be a mere myth for those who will come after us But it is the wounds of the spirit that it is ever so difficult but urgently important to heal, so that love and faith and hope may replace the spirit of hatred and revenge Children know no barriers of race or creed Let us not educate them to know them . "

Miss Ellen Wilkinson, M P, Minister of Education, Great Britain, and President of the Conference, said

"Now we are met together, workers in education in scientific research and in the varied fields of culture We represent those who teach, those who discover, those who write, those who express their inspiration in music or in art We have a high responsibility, for entrusted to us is the task of creating some part—and not the least important part—of that structure of the United Nations on which rest our hopes for the future of mankind It is for us to clear the channels through which may flow from nation to nation the streams of knowledge and thought, of truth and beauty which are the foundations of true civilization"

"Wars", said Prime Minister C. R Attlee, "begin in the minds of men And we are to live in a world of democracies where the mind of the common man will be all important We have left behind us the days when kings and their statesmen could declare war at will, regardless of the feelings of their subjects, and we have no proof that democracies of itself is a protection against a readiness to make war"

The history of events finally culminating in the proposal for the establishment of UNESCO and an account of international organizations previously set up for co-operation in scientific, cultural and intellectual fields are detailed in an article which appears elsewhere in this issue The UNESCO has, however, not yet come into existence, its formal establishment is expected to be announced at the General Conference, now being held in Paris

Meanwhile, a Preparatory Commission was established at the last November Conference to prepare provisional agenda for the first session of the General Conference, to prepare documents and recommendations relating to all matters on the agenda, to make specific arrangements between the UNESCO and the United Nations Organization (UNO), and finally to make arrangement for the Secretariat of the Organization and the appointment of the Director-General Sir Alfred Zimmern, a well known British scholar, was chosen as the first Executive Secretary by the Preparatory Commission, but was unable to continue his duties owing to illness. Dr Julian Huxley, the well known British scientist and writer, has now taken his place The Preparatory Commission has divided its activities under a number of sections, of which the principal ones are

(a) Education ;
(b) Natural Sciences ;
(c) Social Sciences ,
(d) Arts ,
(e) Letters and Philosophy ,
(f) Mass Media (Press, Radio, Cinema) ;
(g) Libraries, Museums & Publications ,
(h) Public Relations ,
and (i) War Devastated Areas

In addition to these, there are a number of sections concerning internal organization

More than ordinary significance attaches to the inclusion of the word 'scientific' to the title of the Organization. Since the Allied Ministers of Education conferred in London in November 1942, most of the discussions centered round the desirability of establishing a United Nations Educational and Cultural Organization A sub-committee was, however, formed to deal with scientific questions, but there was at first some reluctance to mention the word 'science', and proposals to include it in the title were actually rejected In November 1945 Conference in London, the word 'Scientific was finally introduced into the title of the Organization, after considerable debate, on the proposal of Archibald MacLeish, the Head of the U S Delegation to the Conference

The emphasis on science in any programme of educational and cultural activity to be carried out on an international scale is obvious enough That science is going to play an increasingly important part in remoulding future education is not in doubt today In a world, where forces of science and technology have not only influenced the economic and political patterns in a large measure, but have reacted profoundly upon social institutions and behaviour, the cultural significance of science need not be over emphasized The definite mention of science indicates a recognition and guarantee of the part science will be called upon to play in reshaping future education and culture Moreover, even up till now, there has been hardly any other subject more international than science While marked tendencies to preserve and maintain strong national characteristics, not infrequently hostile to those of other nations, are clearly known to exist in the fields of education and culture, science is particularly free from any such complaint. Men of science of many nationalities have co-operated since the beginning of scientific thinking and practical experimentation, and international unions or bodies or societies were among some of the early organizations to be set up, whose activities were not confined by the geographical limits of any country. The conscious welding of

science with such international background in a world organization for the propagation of education is expected to relieve education of its narrow national bias and enable the forces of education to exert themselves in restoring faith and goodwill among nations

As regards some specific projects which the scientific divisions of the UNESCO are likely to undertake,* there has already been considerable discussion at the last November discussion and since Such activities as Dr Julian Huxley, Mr J G Crowther and many others (*Nature*, November 10, 1945) seem to foresee may include .

(*a*) co-ordination of activities of the existing international bodies in science such as the International Scientific Unions, the locust control organization, etc , and provision for assistance, financial or otherwise ;

(*b*) arrangement to promote scientific bodies or initiate and carry out, through its own agency, research and survey in those fields of scientific enquiry, for which suitable scientific agencies are either inadequate or non-existent ,

(*c*) speedy dissemination of scientific knowledge, information and ideas through exchange of books, periodicals and reports, through the improvement and expansion of publication, translation, abstracting library and other services, and through provision for special meetings and research visits of scientific workers in many fields, normally scattered in different places and countries ,

(*d*) exchange of research workers as well as teachers, including both the school and the university teachers , provision for liberal research fellowships and studentships to enable workers of proved ability to work in the scientific laboratories of foreign countries

Mr Crowther mentions another important work which the scientific divisions of the UNESCO should immediately undertake He refers to the world needs of scientific equipment and draws pointed attention to the striking lack of statistics regarding the existing scientific equipment in the laboratories and educational institutions. Collection of this important statistics must precede any planning for equipping the laboratories on such a scale as permits teaching and research in the most modern subjects An assessment of the exact needs will also facilitate mass production of scientific instruments at a much reduced cost "For example", says Mr Crowther, "steam engines of various kinds are needed for engineering laboratories Their price varies greatly according to whether they are needed in lots of five or five hundred The cost of scientific rehabilitation could be greatly reduced if the world manufacture of scientific equipment could be to some extent rationalized "

These and many others will be some of the important and fruitful directions in which the scientific divisions of the UNESCO can start work. It should, however, be clearly realized that, although the organization will be responsible for many important scientific activities on an international level, it will not—in fact, it cannot—represent the entire field of scientific activity. Since science today permeates almost every department of human activity, it is doubtful whether any single agency or body can ever do so Already a number of international organizations such as the United Nations Food and Agriculture Organization, the United Nations Health Organization, the International Monetary Fund, the Atomic Energy Commission have come into existence, and each of these organizations will have its own distinct and important sphere of scientific activity. The Food and Agriculture Organization, for instance, will be, to a great extent, responsible for all scientific aspects of food, nutrition and agricultural practices, including questions of fertilizers, plant breeding, improved seeds, weed-killers, preservation of food, etc So also with Health The newly constituted Atomic Energy Commission will be deeply concerned with and have control on research and further development of atomic energy primarily from the point of view of world security and prevention of military use of atomic energy Even the International Monetary Fund will require scientific advice at many stages. The future relationship with the United Nations Organization of all these organizations and of others that may be created is now under consideration As it appears from the constitution and structure of the UNO, the most fitting link will be through the Economic and Social Council The United Nations Educational, Scientific and Cultural Organization may be linked, with other international bodies, with this Council

The impracticability of establishing one single international scientific organization and the active interest and actual participation in scientific research, investigation and survey on the part of several international organizations make the question of coordination exceedingly important Since all these organizations are expected ultimately to work under the authority of the Economic and Social Council of the UNO, one suggestion has been that this coordination can be most effectively made at the Council level. Special committees in which will sit eminent scientists and experts in advisory capacity may be constituted. Dr Joseph Needham has proposed the creation of a Scientific Commission, with a Secretariat. The Dumbarton Oaks proposals already envisaged Economic and Social Commissions to assist in the work of the Economic and

* As we are going to the Press, we have just received the full text of proposals for the tasks and functions of the Secretariats' Division of Natural Sciences, as prepared by the Preparatory Commission, UNESCO, a note on which will appear in our next issue.

Social Advisory Council The addition of a similar Scientific Commission has no doubt great merits and will secure for science proper representation at the Council level However, these questions are still under discussion, and very soon suitable solution for the question of effective coordination of all scientific activities, on an international basis, will be available One thing that has emerged from all these discussions and deliberations and which has so far filled men of science with hope and assurance is the evidence of awareness on the part of those who control high policies to see science figure prominently, along with politics and economics, in international organization

INTERNATIONAL CO-OPERATION IN SCIENCE

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THE supreme benefit accruing from collaboration in the field of science among nations during times of war has been amply demonstrated in World War II. One of the factors which has so strikingly contributed to the Allied victory in this war has been the common effort of men of science of the United Nations to pull all technical information and resources and bring them to bear on the successful prosecution of the war By maintaining and promoting the traffic of technical information during the period when normal peace-time methods signally failed to operate, the government scientific liaison agencies played a unique role and considerably helped to establish technical superiority over the enemy in many war-time developments, without which the war might well have been lost The war has been won , but none of the problems, except the military defeat of the enemy, has been solved On the contrary, mankind is confronted with the more difficult problems of peace, which require, for their solution, mobilization of even greater technical resources and far more extensive international co-operation in science It is the considered opinion of all who had first-hand knowledge and experience of war-time collaboration in science that the same should be extended and intensified on a much wider scale through new agencies best suited to peace-time conditions

While war has forced attention on the question of scientific co-operation between nations, it should not, however, be forgotten that such co-operation existed, in some form or other, almost since the beginning of scientific enquiry The very edifice of science, as we know it today, has been built up by individual and groups of scientists of many nationalities Even the military utilization of the atomic energy, over the question of whose monopoly nations are now wrangling with one another, has not resulted from the investigation and researches of any one single nation, but represents the culmination of a long line of researches to which more or less all the civilized nations contributed Exchange and cross-fertilization of ideas among scientists of different countries through congresses, correspondence, personal visits and contacts, the system of visiting professorships, etc , have always been a permanent factor in the progress of science, and many voluntary international organizations with a view to promoting better co-operation among scientists sprang up in the past If the question of international co-operation in science has today pressed on world attention, it is because many gaps still exist, the old organizations in many places require to be scrapped, and new and workable ones evolved Never was planned and co-ordinated development of all branches of science, fundamental and applied, as a means for furthering human welfare, more strongly felt than at present

In the following note, an attempt will be made to describe the work of some of the existing international organizations in science and discuss the new organizations proposed for the future We have to deal with primarily two groups of international organization, namely, those sponsored by unofficial bodies such as scientific societies, academies, or associations or sometimes by groups of individual scientific workers, and those established by governments, as in times of war Then, there are also the organizations sponsored and established by the League of Nations.

1. NON-OFFICIAL INTERNATIONAL SCIENTIFIC ORGANIZATIONS

It is needless to mention that the early efforts to establish international co-operation in certain sciences came from non-official academies and from enthusiastic groups of academic scientists. Astronomy was one of the first subjects to have demanded international co-operation in its development There is on record that as far back as 1824 Bessel proposed a plan for a general survey of the heavens, in which the astronomers of all countries were to co-operate,

and the Berlin Academy took active interest in its promotion. The subsequent years witnessed a rapid growth of international astronomical societies, and by 1914 not less than 32 separate organizations were in existence. Next to astronomy, geodesy and seismology claimed attention as international subjects, and International Geodetic and Seismological Associations were established.

International Association of Academies

In 1900, the International Association of Academies was formed, with the national academies of different nations as its constituent members. This was an important step, as it assured co-ordinated scientific activity on the part of all academies, and through it, international co-operation in science. Unfortunately the Association was short-lived and was dissolved after World War I. The principal reason was political. The Association was brought into existence mainly through the efforts of German Academies (Berlin, Gottingen, Heidelberg, Leipzig and Munich) and no doubt bore the impress of German influence and leadership, to the considerable dislike and dissatisfaction of the victorious Allies. The Allied nations—England, France and U. S. A.—withdrew from former international organizations, most of which had their origin in German initiative, and decided to establish a separate international body. The well known International Research Council, later reconstituted into the International Council of Scientific Unions, was thus created in July 1919.

International Research Council—International Council of Scientific Unions

The scheme for an International Research Council was prepared and submitted by the U. S. National Academy of Sciences at the inter-allied conference on international scientific organizations, held in Paris in November 1918. The main object of the proposed Council was the establishment of international unions in the major scientific fields under the general administrative control of the Council. The plan further proposed that the National Academies or similar representative scientific bodies would control the activities of the national sections of the Unions. The International Research Council was formally inaugurated in July 1919 at a conference at Brussels, and, along with it, International Unions of Astronomy, Geodesy and Geophysics, and Chemistry were established. Unions of Physics, Geography, Biology, Paleontology, and Scientific Radio were formed later, while those of Geology, Medicine and Bibliography, despite preparation of draft statutes, never materialized.

The International Research Council, as already stated, had considerable administrative control upon the Unions, particularly with regard to finance and admission of new members to the Unions. There was a clause which debarred any country from entry into a Union unless that country was first a member of the Council. This clause was introduced mainly with the narrow purpose of excluding the former enemy countries of Central Europe from the Unions, and on one occasion, the proposal to invite the Central Powers to join the Unions was actually turned down at the general meeting of the Council. Gradually much dissatisfaction was expressed over such irksome control of the Council upon the Unions, and need for a thorough reconsideration of the statutes of the Council arose. A Committee was appointed in 1928, with Sir Henry Lyons as its secretary, who later became the General Secretary of the International Research Council, to recommend the needed changes and modifications of the statutes of the Council. The Committee recommended wider powers and freedom to the Unions in the matter of membership, finance and other questions and direct representations of the Unions on the General Assembly. With these modifications, the Council was reduced largely to the position of an advisory body and ultimately came to be controlled by the Unions just as it had formerly controlled the Unions. The name of the Council was also changed into International Council of Scientific Unions (1931), a change which corresponded more closely with the statutes and functions of the new Council. The present President and Vice-President of the Council are Dr H. R. Kruyt and Dr E. D. Merrill, and Prof F. J. M. Stratton is the General Secretary.

The meetings of the General Assembly in which all the international Unions report and deliberate are convened once in every three years. On the occasion of these triennial meetings each Union appoints a small bureau of officers to answer for the Union as a whole between meetings. In between the General Assembly meetings, the Unions continue their work through specialist committees which at present total 92 in number. The Astronomical Union, for instance, has 34 standing committees which represent a wide range of activities in the entire field of astronomical science. The Union of Geodesy and Geophysics has seven sections to represent geodesy, meteorology, seismology, atmospheric electricity and magnetism, oceanography, hydrology and volcanology. Recently this Union has formed a Committee on the Social Value of the Earth Sciences to prepare a 'general statement in the value of the earth sciences for human welfare.' The Union of Geodesy and Geophysics has, moreover, helped to organize and establish International Commissions on Snow and Glaciers, Subterranean Water, and the Continental and Oceanic Structure. The Union of Scientific Radio has carried out much valuable work of common interest, con-

cerning frequency standards, ionospheric changes, atmospherics, ultra-short waves, and much still remains to be done in these directions The Union of Chemistry has largely concentrated on the work of preparing and issuing annual tables of constants, atomic weights, and physico-chemical data, of great international importance. The Union has also carried out investigations into the question of nomenclature in inorganic, organic and bio-chemistry and has taken active interest in all chemical problems involved in nutrition, clothing and housing The Union of Biological Sciences maintains a number of sections, of which the following are important—botany, general biology, applied biology, physiology, zoology, medical science, and oceanographic biology Of these the botanical section is, however, by far the most active section The various important questions which have so far received the attention of the standing committees include unification of nomenclature, taxonomic needs, preparation of an index of plant science periodicals and of a geobotanical map of Europe

In addition to the work of the International Unions, mention should be made of the work of special committees and joint commissions of the Unions, which are set up by the International Council of Scientific Unions from time to time Special committees are established to tackle such questions as are not likely to be taken up by any of the existing Unions. Thus the Council has set up committees on Solar and Terrestrial Relationship and on Science and Social Relations The Council has introduced the system of joint commissions to deal with particular problem or problems in which more than one Union is interested Such joint commissions on latitude variation, on the determination of longitudes by wireless etc. have successfully worked for a long time Recently joint commissions on ionospheric research, oceanography, physico-chemical constants, and viscosity have been proposed

International Congresses

Another type of organizations which have significantly contributed to international co-operation in science are what are known as international congresses Notable examples of such organizations are the International Geological Congress, the International Botanical Congress, the International Horticultural Congress, the International Mathematical Congress, the International Congress of Applied Mechanics, the International Congress of Psychology and the like. Co-operation in medical sciences has been secured largely through International Congresses and Associations. Thus, there are International Congresses for Mental Hygiene; Pediatrics, Neurology, Physiology, and Gastro-Enterology ; and Associations for Microbiology, Leprosy, Urology and Psycho-Analysis The congress form of international organizations differs from the union type in that, unlike the unions, the congresses do not maintain permanent bureaus, nor maintain committees to function between the annual or periodical meetings The congresses are primarily designed to present periodical occasions for scientists normally working at different centres to meet, establish personal contacts, and discuss problems of common interest They are generally not intended to act as scientific bodies charged with the task of carrying out certain specific researches, investigations, or surveys This periodical gathering of scientists from many lands is the principal attraction of these international congresses In a memorandum on 'International Relations in Science' prepared by Dr W B Cannon and Dr Richard M Field and published in *Chronica Botanica*, Vol 9, No 4, the following distinction between congresses and unions has been drawn

> "The scientific congresses do not function between meetings, and, at times, are more subject to political opportunism, as in the case of the last or Eighth American Scientific Congress. The mechanism of the International Scientific Union includes *Bureaux* which are expected to function continuously between meetings, and the Unions are financed by all countries which adhere to one, or more, of them The control of each Union, however, is through its Bureau whose officers are elected at a General International Assembly "

International Scholarships and Fellowships

A number of international trust funds offering research fellowships and scholarships to scientific workers of proved ability, irrespective of their nationalities, have also played useful part in the promotion of international co-operation in science The 1851 Exhibition Scholarships, the Rhodes Scholarships, the Commonwealth Fellowships, and the scholarships offered by the Rockefeller Foundation, the Lady Tata Memorial Trust (India) and the Watumull Foundation are instances in point The Royal Society and the Academy of Sciences, U S. A , jointly administer the Pilgrim Trust Fund which enables eminent British and American scientists to deliver periodical lectures in the U S A. and the the United Kingdom respectively

2. Organizations under the League of Nations

International Committee and Institute on Intellectual Co-operation

The question of inter-governmental action in the sphere of intellectual co-operation was brought up after World War I at the Peace Conference of 1919. The idea did not at first receive much encouragement ; the efforts were not, however, given up, and at the Geneva Conference, a French statesman, Leon Bourgeois, pressed for the creation of a League of

Nations Committee on Intellectual Co-operation and secured the approval of the Assembly In 1922, the League Council established the International Committee on Intellectual Co-operation, with twelve distinguished scholars, scientists and men of letters The work of the Committee became easier when two years later, in 1924, the French Government offered to establish the Institute of Intellectual Co-operation in Paris and requested the League to assume management and control of the Institute. The Institute came into existence with the International Committee on Intellectual Co-operation as its governing body, which maintained a secretariat at the League headquarters in Geneva

At first the scope of the Committee and the Institute was very limited The object of the sponsors of these organizations was to promote understanding, harmony and peace among nations through active cultural and intellectual co-operation But the mutual distrust and a strong desire to maintain national sovereignty created difficulties in the selection of subjects and fields for intellectual co-operation The Committee was not allowed to take up even general educational problems which were considered national subjects, and was asked to concentrate on "less controversial activities" The main activities of the Institute included exchanges of information among museum and archive officials, studies of the problem of rights in intellectual property, researches on visual aids to education through the Educational Cinematographic Institute at Rome, and the intellectual causes of the growing international crisis. The Institute, it is of interest to note, was closely linked with the International Council of Scientific Unions In fact, since 1938, it has served as the secretariat of the Council and co-operated with the latter body in organizing special scientific conferences in problems of physics, meteorology etc It also initiated some new enterprises such as the compilation of dictionaries and catalogues

Despite some good work to its credit, the Intellectual Co-operation Organization failed to function as a live organization Its influence on the lives of the common people was not very tangible, and activities were confined mainly within a small group of philanthropists. The fate of the Institute is at present uncertain and the general expectation is that it will be discontinued as soon as the United Nations Educational, Scientific and Cultural Organization, to which we shall refer later, comes into operation

The International Bureau of Education

We have already referred to the failure of the League to establish a suitable international agency to grapple with educational problems But the need for an international agency to promote educational understanding was never lost sight of In 1925, the International Bureau of Education was established in Geneva, as a voluntary research agency. The Bureau soon received a semi-official status when it enlisted as members fifteen governments and two non-governmental agencies The Bureau undertook important studies in the methods of education, and mainly served as a clearing house of information on education in various countries

3 Scientific Collaboration During World War II

In the foregoing, we have discussed some of the peace-time international organizations in science With the outbreak of hostilities in Europe, it became abundantly clear that the peace-time organizations for scientific co-operation among nations would be of no avail during the emergency of a war The need for total mobilization of all scientific resources and closer and fuller inter-governmental collaboration in all technical matters pertaining to defence called for new types of organizations Regarding the inadequacy of peace-time organizations during war, Dr K T Compton, president of the M I T, once remarked (Pilgrim Trust Lecture, May 20, 1943)

> "I have frequently tried to analyze the reasons for the establishment of special scientific agencies during times of crisis They are, I think, varied and rather fundamental One of them is that every great crisis involves conditions so different from the normal situation that the types of organizations which can survive and operate during peace-time are not adequate to meet the emergency It may be, for example, that the emergency calls for exercise of very extensive administrative functions, such as the supervision of research projects and the disbursement of large governmental funds to a far greater extent than in peace-time Hence a peace-time body of scientific men organized primarily to exercise advisory functions may not be organized in the manner suited to prompt and efficient executive action"

The need for such war-time inter-governmental collaboration in science was successfully met by the institution of scientific liaison offices in the capital cities of the Allied Nations Thus the Government of the U S A established in London an American Scientific Liaison Office, under the executive authority of the Office of Scientific Research and Development (O S R D) This was reciprocated by the establishment in Washington of the British Central Scientific Office which later, with the establishment of the Dominion liaison offices and scientific missions, developed into the British Commonwealth Scientific Office (B.C S O) Scientific collaboration between China and the United Kingdom was secured through the establishment of the Sino-British Science Co-operation Office in Chungking Originally this Office was sponsored by the British Council, with which it was in continuous contact in matters of pure science Regarding defence matters, it closely co-operated with the office established in China by the British Ministry of Production. The Anglo-Soviet Science

Collaboration Committee, set up in London, was responsible for much useful co-operation between Britain and U S S R in the exchange of scientific information Besides, a number of medical missions, e g., the Surgical and the Chemotherapeutical Missions, were organized between those two countries

Space would not permit discussion of the work of each of these liaison offices A brief account of the work of the British Commonwealth Scientific Office in Washington, typical of all the war-time science collaboration offices, may be given here

British Commonwealth Scientific Office

The British Central Scientific Office (1941) had its origin in the visit to U S A of a British Technical Mission headed by Sir Henry Tizard The establishment of this Office was soon followed by the formation in Washington of Scientific Liaison Offices by the Governmets of Australia and New Zealand At first these offices were attached to the Australian Legation and the New Zealand Supply Mission respectively Later on South Africa and Canada also established liaison offices, and an Indian Scientific Mission which visited U K, U S A, and Canada towards the fall of 1944, strongly favoured the creation of a similar Indian Scientific Office Thus when all the important members of the Commonwealth established scientific offices in Washington, it was thought advisable to federate them in a single body, and the British Commonwealth Scientific Office was created The name of the original British office was changed into United Kingdom Scientific Mission (U K S M) Working under this federation, the individual liaison offices, however, retained considerable autonomy and independence of action Only such common services as clerical staff, library facilities, arrangements for photography and the copying of reports, purchase of books, specifications and periodicals, travel and hotel reservation, arrangement for clearances, etc were jointly organized

Besides arranging for travels and visits of the respective Government representatives, the B C S O maintained a comprehensive library of technical information, took active part in the purchase of scientific stores, and in many defence research projects concerning gun erosion, development of rockets and other special weapons, light alloys for aeroplane construction, chemical explosives, medical and agricultural research problems, etc Many questions such as those on D D T and insect control measures, food processing and nutrition, prevention of equipment deterioration in the tropics, were jointly tackled by representatives of the various liaison offices of the B.C S.O. A proposal has recently been made to continue in peace-time the work of the British Commonwealth Scientific Office and secure better and more lasting scientific collaboration among the British Commonwealth of Nations.

4 Post-War International Organization in Science and the United Nations Organization

The scientific collaboration offices established during the war were temporary measures designed to tide over an emergency During World War I, many temporary agencies to promote co-operation among nations were brought into being, but were later scrapped with the cessation of hostilities This time the considered opinion of many interested people seems to be otherwise There is everywhere complete awareness of the immensity of post-war problems and none whose opinion counts has sought to minimize them No one has doubted that there will be need for more science and a fuller and more fruitful collaboration among nations in the field of science and technology "Upon there being a scientific approach to human problem", said Rt Hon Herbert Morrison, "depends the future of man Without the technique of the scientific method, without this matter-of-factness, we shall be befogged by ignorance, by dogmas and by our emotions, and the world will never be rid of its explosive cross purposes and muddle-headed wrangling"

Dr Joseph Needham, formerly head of the Sino-British Science Co-operation Office in Chungking, who has given much thought to the problem of post-war international collaboration in science, observed thus

> "What we need today, then, is fundamentally an attempt to combine the methods which the world of science has spontaneously worked out for itself in periods of peace, with those which the nations have had to work out under the stress of war The methods of peace time have included the periodical International Congresses in the various sciences, at which numerous lectures and demonstrations are given, and the International Unions or permanent Bureaux which function continuously in some sciences The methods of war time involve the Science Co-operation Offices which have been established in both World Wars in London, Washington, Chungking etc None of this machinery ought to be scrapped The problem is to weld it into a satisfactory functioning system "

Strong desire has been expressed in favour of taking advantage of the rich experience of war in the field of scientific co-operation The success of these war-time organizations has been mainly attributed to direct governmental interest, availability of liberal funds, and adequate secretariat, and these conditions must also characterize the post-war scientific organizations Already practical steps and decisions have been taken in these directions, and important organizations which will deal with vital scientific matters and ultimately function under the executive authority of the United Nations Organizations have been mooted and are now in the process of being set up.

We specially refer to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the United Nations Food and Agricultural Organization (UNFAO), and the Atomic Energy Commission, all of which are entrusted with important scientific work affecting the peoples of the world If science is to play its useful and unique role in future reconstruction and rehabilitation, and in the promotion of economic and social welfare, it must be represented in the highest international organization, and efforts are now being made to that effect. By laying down the principle of international co-operation in the field of economic, social and other humanitarian matters in the Charter and by creating the Economic and Social Council as an organ to give effect to it, the UNO has laid the foundation of future international co-operation in science and other spheres Article I, Section 3 of the Charter, dealing with the purpose of the UNO, states

"To achieve international co-operation in solving international problems of an economic, social, cultural, or humanitarian character, and in promoting and encouraging respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion "

Article 55 of the Charter further states

"With a view to the creation of conditions of stability and well-being which are necessary for peaceful and friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples, the United Nations shall promote .

(a) higher standards of living, full employment, and conditions of economic and social progress and development,

(b) solutions of international economic, social, health, and related problems, and international cultural and educational co-operation, and

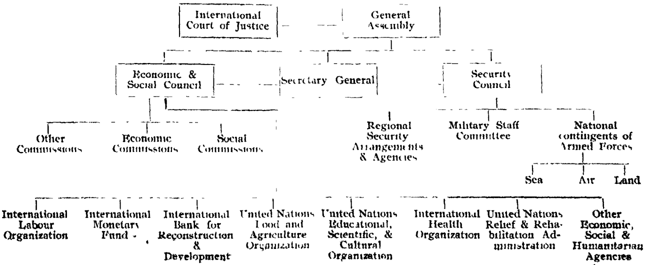
(c) universal respect for, and observance of, human rights and fundamental freedoms for all without distinction as to race, sex, language, or religion "

The relation of the various organizations with the General Assembly, as proposed in the Dumbarton Oaks Proposals, is shown in the Chart. In the following, a brief account of the UNESCO, the UNFAO, and the Atomic Energy Commission will be attempted.

(A) The United Nations Educational, Scientific and Cultural Organization

Since the last Great War, educators and workers in cultural field have been trying in vain to secure international co-operation in educational and cultural spheres. Some meagre efforts were made through the League of Nations Intellectual Co-operation Organization, the Institute of Intellectual Co-operation, and the International Bureau of Education ; but owing to lack of support and particularly on account of the rise of aggressive nationalism in Europe, these organizations never succeeded in attaining their desired object The catastrophe of the second Global War once more focussed attention on the desirability of developing and organizing educational and cultural forces with which to create the atmosphere of peace, and mutual understanding among nations The first practical step was taken when, in the autumn of 1942, on the initiative of the British Council, the Ministers of Education of the governments-in-exile in London held conferences to discuss the post-war educational needs of the occupied countries The Conference of Allied Ministers of Education (C A M E), as it has been called, met on several occasions between 1942 and 1945 and appointed about ten commissions and committees to study and report on various problems of educational and cultural reconstruction, such as provision of books, restocking of libraries and laboratories, the training of personnel, the care and restoration to their right-

The Chart showing the various International Agencies with the UNO



ful places of looted works of art, etc The work of the C A M E was appreciated by the U S State Department, which decided to send an American educational mission to London In April 1944, Hon J William Fulbright, then Representative and new Senator, headed the American Educational Delegation which fully participated in the work of the C A M E in developing a plan for international co-operation in education

The original intention of the Conference of Allied Ministers of Education was to set up a provisional organization primarily concerned with the task of restoring the educational and cultural heritage of the war-devastated countries The idea of a permanent international educational organization developed later and was further reinforced by the Dumbarton Oaks Proposals These proposals from which we have quoted earlier recognized the necessity of international co-operation in social and humanitarian spheres and 'envisaged a system of specialized agencies in various fields of co-operation, working in close relationship with the General United Nations Organization, the Economic and Social Council being the organ through which their activities might be co-ordinated' At San Francisco, the phrase 'educational and cultural co-operation' was specifically included in the UNO Charter Henceforward, work was directed towards creating a United Nations Educational and Cultural Organization (the word Scientific was introduced later) and the C A M E undertook to prepare the draft constitution of the proposed organization The draft constitution as prepared by the C A M E and another one submitted by the French Government were discussed at a Conference convened for this purpose in November 1, 1945 at London, at which representatives from 44 governments were present This Conference which continuously sat for two weeks drew up the final constitution establishing the United Nations Educational, Scientific and Cultural Organization

The purposes and functions of the UNESCO, as set forth in the constitution, run as follows

The purpose of the Organization is to contribute to peace and security by promoting collaboration among the nations through education, science and culture in order to further universal respect for justice, for the rule of law and for the human rights and fundamental freedoms which are affirmed for the peoples of the world, without distinction of race, sex, language or religion, by the Charter of the United Nations

To realise this purpose the Organization will

(a) collaborate in the work of advancing the mutual knowledge and understanding of peoples, through all means of mass communication and to that end recommend such international agreements as may be necessary to promote the free flow of ideas by word and image,

(b) give fresh impulse to popular education and to the spread of culture, by collaborating with Members, at their request, in the development of educational activities, by instituting collaboration among the nations to advance the ideal of equality of educational opportunity without regard to race, sex or any distinctions economic or social, by suggesting educational methods best suited to prepare the children of the world for the responsibilities of freedom,

(c) maintain, increase and diffuse knowledge, by assuring the conservation and protection of the world's inheritance of books, works of art and monuments of history and science, and recommending to the nations concerned the necessary international conventions, by encouraging co-operation among the nations in all branches of intellectual activity, including the international exchange of persons active in the fields of education, science and culture and the exchange of publications, objects of artistic and scientific interest and other materials of information, by initiating methods of international co-operation calculated to give the people of all countries access to the printed and published materials produced by any of them

The head-quarters of the UNESCO will be in Paris The Executive Board to be elected at the General Conference meeting annually in ordinary session, shall consist of 18 members, each well-known for his contribution to arts, sciences, humanities, or education The Executive Board shall nominate and, the General Conference appoint, the Director-General whose term of office will be for a period of six years Under the Director-General shall work a Secretariat, whose staff will be appointed on as wide a geographical and cultural basis as possible The constitution provides for the establishment of National Commissions, to be formed by Member States with their principal bodies interested in educational, scientific and cultural matters These Commissions will function as agencies of liaison between the Government concerned and the Organization

The UNESCO will formally come into existence at its First General Conference now being held in Paris To conduct this Conference, a Preparatory Commission, with a small secretariat, was created in London at the last November Conference Dr Julian Huxley F R S the eminent British scientist and writer, has been appointed the Executive Secretary, and an executive committee of 14 members was set up The work of the Commission has been divided under the following important sections · Education, Natural Sciences , Social Sciences , Arts , Letters and Philosophy , Mass Media (Press, Radio, Cinema) , Libraries, Museums and Publications , Public Relations ; and War-devastated Areas

Very high hopes have been expressed over the establishment of the UNESCO The cherished dream of educators, scientific discoverers, and workers in the field of arts and culture to build peace upon the intellectual and moral solidarity of mankind and make the world safe for democracy is now in its way to realization "UNESCO", as the U S. State Department's Document puts it, "is to be a star of first magnitude in the new world constellation of the United Nations It will also be a sun around which

a system of great world associations both public and private will cluster, shedding and receiving both light and warmth."

(B) The United Nations Food and Agriculture Organization

The scientific aspects of food, agriculture, nutrition and allied subjects will be the concern of the newly established United Nations Food and Agriculture Organization (UNFAO) Peace is a distant dream as long as vast sections of the people are condemned to starvation diet and gross malnutrition particularly when science and technology have proved beyond doubt that we are living in an age of potential plenty The tragedy of pre-war short-sighted national policy in destroying surplus foodstuff with a view to keeping up agricultural prices must not be allowed to recur in future These considerations led the United Nations to evolve a plan for an international food and agriculture organization at Hot Springs and finally establish the UNFAO in October, 1945 at the Quebec Conference Sir John Boyd Orr, former director of the Rowett Research Institute and well-known nutrition specialist, was appointed the first Director-General

The main purpose of the Organization will be to secure freedom from want to all people irrespective of race and colour This will be done by fostering food production, by applying technical knowledge to agricultural practices to the fullest extent possible, and by rendering immediate relief to the people of the war-devastated countries The UNFAO will undertake comparative studies of world food needs, a complete world survey of production, consumption and international trade in important agricultural products, and a world census in 1950 with the object of preparing a World Food Plan The constitution of the Organization provides for the establishment and maintenance of panels of technical experts to deal with specific problems of food and agriculture

At a recent Conference in Copenhagen, Sir John Orr sponsored the establishment of a World Food Board (Science and Culture, September, 1946) with the object of

(*a*) stabilizing prices of agricultural goods in world markets,

(*b*) establishing a world food reserve adequate to meet any emergency caused by crop failure anywhere,

(*c*) providing funds to finance disposal of surplus agricultural products to countries urgently needing them, and

(*d*) co-operating with organizations concerned with international and agricultural development and with trade and commodity policy

The establishment of a minimum food target of 2,600 calories per person daily received general agreement The UNFAO will again meet this month at a conference in Washington to prepare plan for the World Food Board

Working in close co-operation with the UNRRA, the United Nations Food and Agriculture Organization is destined to play a vital role in connection with the post-war international food and allied problems At the Quebec Conference, Sir John Orr observed that the time had come when tanks were turned into tractors and factories which manufactured explosives were converted to produce fertilizers and humanity entered an era of peace and plenty

(C) The Atomic Energy Commission

The first explosion of the experimental atomic bomb in the desert of New Mexico heralded the beginning of a new age, the Atomic Age Its use against Japan in August 1945 raised grave political issues While there has been unreserved condemnation from all quarters against military use of atomic energy, U S A, Britain and Canada who claim to hold secrets of manufacturing atomic bombs have steadfastly refused to share atomic knowledge with other nations However, the major Powers have decided to establish international control of scientific work relating to atomic energy as a safeguard against probable manufacture of atomic bombs for use in future wars Recently, the United Nations Organization has set up the Atomic Energy Commission consisting of one representative from each of the members represented on the Security Council and a member from Canada, and having the following terms of reference

"The Commission shall proceed with the utmost despatch and enquire into all phases of the problem, and make recommendations from time to time with respect to them as it finds possible

In particular, the Commission shall make specific proposals

(*a*) For extending between all nations the exchange of basic scientific information for peaceful ends

(*b*) For control of atomic energy to the extent necessary to ensure its use only for peaceful purposes

(*c*) For the elimination from national armaments of atomic weapons and for all other major weapons adaptable to man's destruction

(*d*) For effective safeguards by way of inspection and other means to protect complying States against the hazards of violation and evasions"

Much controversy is at present raging over the question of international control of atomic energy. While the necessity of some form of control against possible military use of atomic energy is not called in question, it is apprehended that loss of freedom of scientific investigations in an important branch of natural science may result from such control

It is not possible to foressee the extent of this apprehension at this stage, but there is no doubt that until such times as the fear of war is completely removed from men's minds, nuclear research needs must be a subject of international concern and control The way in which such control can be best exerted with least interference on the freedom of research and investigations directed towards peaceful ends is now under consideration and forms the subject of a number of reports* recently issued from U S A and Great Britain, to which the attention of the interested readers may be invited

Conclusion

Upon our ability to fully harness science and technology for the cause of peace depends the future well-being of mankind An indivisible peace must be attained and maintained by joint efforts of nations through such activities as are calculated to foster goodwill among nations If this goodwill and sense of living in One World ever existed in any group of people, it did only among men of science "If there is any nucleus of international goodwill and understanding left in the world," said T B Appleget, "it resides, I think, in scientific personnel They will be the first to mend the broken wires of communication, and I hope this time all the world will realize, whether we like it or not, we have to live together on a globe which science has made too small for war" (*Chronica Botanica*, Vol. 9, No 4, p. 258). If the responsibility of winning a technical war largely rested on the united action of scientists, the more urgent responsibility of leading the world in matters of co-operative effects for the promotion and continuance of a peaceful technological civilization must also rest on the scientists

* A Report on the International Control of Atomic Energy—Prepared for the Secretary of State's Committee on Atomic Energy by a Board of Consultants, Washington, D C
World Power and Atomic Survey the Impact on International Relations—by H E Wimperis
The Era of Atomic Power—Report of a Commission appointed by the British Council of Churches
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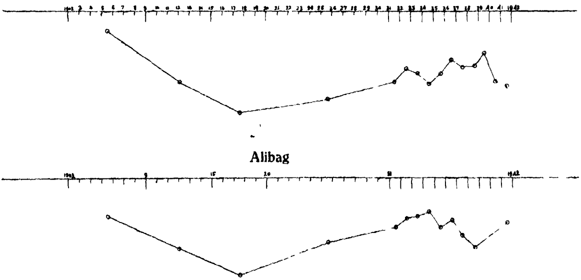
SECULAR VARIATION OF MAGNETIC DECLINATION* IN INDIA

B L GULATEE,
SURVEY OF INDIA

THERE are several physical phenomena which are ostensibly constant but are suspected of being burdened with small secular variations. These suspected changes are usually of the same order of magnitude as the probable errors of their determination and the variations found are often spurious and are traceable to the uncertainty of observations or apparatus. Instances of such phenomena are value of gravity at a place, heights of mountain peaks, continental drift, relative fluctuations of land and sea etc The magnetic field of the earth differs from the above in two respects: (i) the magnetic elements are changing all the time, and (ii) the secular change is indubitable and is large Its delineation, however, is not easy as the following would show. We shall confine ourselves only to a consideration of the magnetic declination alone

The information about magnetic declination in a country is usually displayed in the form of generalized charts which give lines of equal magnetic declination (Isogonic lines) at a given epoch and also lines of equal annual change (Isoporic lines) These latter enable the isogonal lines to be drawn for succeeding epochs No civilized country can do without such charts as they are indispensable for land and hydrographic survey as well as for nautical and aeronautical purposes. For the initial drawing of isogonal charts, a general magnetic survey of an elaborate nature is necessary For India, this survey comprised observations at 1400 field stations and 5 permanent magnetic observatories equipped with continuously recording magnetographs The field work was carried out between 1901 and 1913 and isogonals were drawn for epoch 1909 0 after correcting the field observations for diurnal variation, disturbance and secular variations An important point about these corrections is that while diurnal variation and disturbance at a station can be interpolated sufficiently accurately from the data of fixed observatories which are necessarily a considerable distance apart, the correction for secular variation changes rapidly from place to place, necessitating the supplementing of fixing observatories by a certain number of repeat stations. Apart from the question of funds available, various other factors must be taken into account in deciding upon the number of Repeat Stations and the interval between their successive reoccupation A short period of 2 or 3 years is open to the objection that errors of measurement would have a large effect on the derived rate of change, while the adoption of as long a period as 11 years (corresponding to that of sunspot cycle) involves the risk of certain features of the change being skipped over. From the data provided by the observatories, it appears that secular

Dehra Dun CHART I



Mean Annual Values of δ (declination) plotted against Time Scale 1 cm = 1′

* Many countries now use the term 'Magnetic Variation' for 'Magnetic Declination'.

changes, though not uniformly progressive, can be satisfactorily expressed by straight lines or smooth curves over a period of about 5 or 6 years, after a break occurs in the type of the curve. This is exemplified by Chart I, in which mean annual values of declination at Dehra Dun and Alibag have been plotted against time. The two curves are of the same pattern and point to the existence of short period fluctuations. For any detailed examination, however, it is necessary to plot the monthly values, which, of course, are only available at fixed observatories. Five years is now universally accepted as the interval at which repeat stations should be revisited.

Chart II shows the Isoporic lines or lines of equal change of declination in India derived from intervals 1909-15, 1915-20, 1920-31 and 1931-46.

A study of these isopors even though they cover a short period reveals some interesting facts. The isoporic lines for the intervals 1909-15 and 1915-20 are nearly parallel to each other, there being a simple westerly shift of about 1½ minutes. The isopors in 1920-31 have a tendency to swing in a north westerly direction, but this shift does not appear to have been maintained, the 1931-46 curves swinging back to resume their older shape.

A more interesting and important feature, however, is that in India, which is an area of negative change, these curves do not form closed loops, *i e*, there is no focus of rapid change at present. The focus of negative change is down to the south in the Indian Ocean (beyond the range of Chart II). The nearest focus of positive change is in west Australia. This focus appears to be moving continuously westwards and if the westerly shift of the isopors is maintained, it may soon find its way in India. It is, however, not certain as to how long this westerly movement is likely to continue. It is not improbable that this westerly shift may some time reach its maximum and then swing back, ultimately changing over to an easterly movement. If this happens, this will be an event of no small interest.

To keep secular variation up-to-date after the general magnetic survey of India was completed, it was decided (*a*) to visit quinquennially 80 stations (called Repeat Stations) of the original survey and (*b*) to maintain continuous observatories at Dehra Dun, Kodaikanal, Toungoo and Alibag. These observatories have to be kept running to correct 5-yearly observations at Repeat Stations for diurnal variation and disturbance, which are at times as much as four times the annual secular change.

Even with this programme, however, it is not easy to delineate real change in secular variation pattern, because observed values at repeat stations have to be given certain corrections to reduce them to the mean of months and these reductions are burdened with uncertainties which are of the same order of magnitude as real changes of secular variation. Hence also the necessity of selecting repeat stations at places free from natural or artificial disturbances. The changes sought are so small that any such extraneous disturbances can introduce considerable uncertainties and enhance the difficulties of the task.

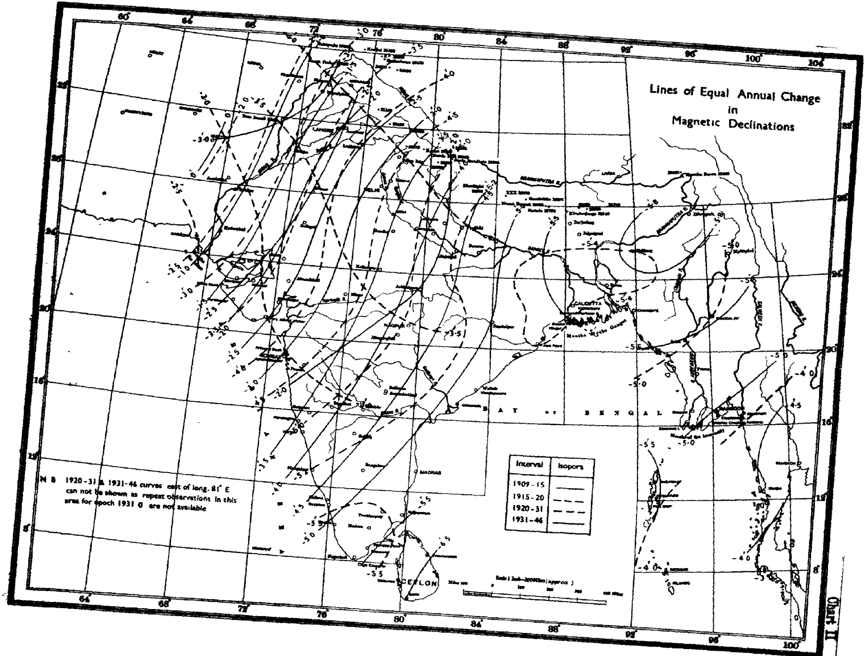
Elaborate work of this nature with no obvious return for the money spent is subject to risk of uninformed criticism from the top. Owing to financial stringency, two of the observatories were shut down in 1923, and during the war the Dehra Dun underground observatory was put out of action on account of its being flooded. No systematic 5-yearly observations at Repeat Stations were carried out either.

The practical effect of this was felt during this war, when declinations had to be put on topographical maps for military purposes. Secular variation had to be extrapolated over a period of 20 years and the situation had deteriorated so far that doubts exceeding 1° regarding the value of declination existed in some parts. In regions where the variation is greater than that in India, the situation can be hopeless. The case of Cocos Island near Andamans affords a good example. Isogonals on the Australian aeronautical series of charts published by the Property and Survey Branch, Department of Interior, Canberra, showed the value of magnetic declination at Cocos Island in 1942 to be 5½°W.

The Chief Geophysicist, Canberra, reported that this value could not be far wrong, inspite of observations being 20 years old as the values of secular variation had been assessed very carefully. In point of fact, however, observations in 1946 by Messrs Chamberlain and McCarthy have shown the accepted value to be in error by as much as 3°. Considerable discrepancies exist between the Admiralty and Australian Charts in the area south of latitude 10° round about Australia and to the west of it in Indian Ocean. The magnetic data in the Indian Ocean are based on the last cruise of the non-magnetic ship Carnegie in 1919 and are consequently very uncertain now. For any work in these oceans and for the outlying islands in India, international cooperation is necessary.

For military purposes, declinations on maps are required to a precision of ¼° or so. To meet this need, observations were carried out by the Survey of India at all Repeat Stations in the year 1943-45 without observatory cover. This procedure is obviously very unsatisfactory, as the corrections for disturbance and storm which can amount to as much as 5′ have to be ignored. One remedy for this, failing perma-

Chart II



Lines of Equal Annual Change in Magnetic Declinations
Interval | Isopors
1909-15
1915-20
1920-31
1931-46
N B 1920-31 & 1931-46 curves east of long. 81° E can not be shown as repeat observations in this area for epoch 1931·0 are not available
BAY OF BENGAL
CEYLON
CALCUTTA
MADRAS
BOMBAY
DELHI
NAGPUR
LAHORE
BRAHMAPUTRA R.
SALWEEN R.

nent observatories, would be to execute observations at each station for a sufficient number of days at different hours of the day to get a good approximation to the true normal value for the place, but this would mount up the cost of the field work

From the scientific point of view also, the case for the study of secular variation is no less strong in spite of the inherent difficulty of its determination There is no adequate explanation yet about the genesis of secular variation It most probably arises from changes within the crust and may well be due to slow movements of the crust with respect to subcrustal material It is not improbable that there are slow dynamic processes in progress in the subcrustal layers and an intensive study of the shift of the isopors may help in their elucidation From this point of view, however, the body of data available is far too small and it is imperative to plan for continuous data over long periods.

The above facts point to the imperative need of reopening the five permanent magnetic observatories in India and declaring the 80 magnetic Repeat Stations of India as protected areas to guard against their encroachment by structure containing iron or electric power lines

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BOTTOM AND TOP YEASTS

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THE recent discovery of a top yeast as a mutant in active cultures of a brewery strain treated for 90 days with acenaphthene renders it possible to view the question of the origin of top and bottom yeasts from an entirely new angle

What is the mechanism underlying the transformation of a bottom yeast into a top one and vice versa ? This question has attracted the attention of investigators ever since the time of Hansen (1905) Industrial yeasts have traditionally been separated into two distinct categories (Guilliermond, 1920 , Henrici, 1941), the top and bottom yeasts The ability of these two distinct categories differ, for, while the top yeasts are able to ferment at low temperatures, the bottom ones can do so only at higher temperatures Investigations on top and bottom yeasts by Trautwein and Wassermann (1930) showed that the rate of respiration of top yeasts is about 77 per cent higher than that of bottom ones Generally top yeasts have a tendency to be uniformly distributed in wort before fermentation and the gas produced early in fermentation carry them to the top, where finding oxygen they become acclimatized to an aerobic existence The curious fact was that the ratio between the fermenting capacity and the respiratory rate remained constant, the fermenting capacity showing a proportionate increase with the rate of respiration. Out of the total sugars both the top and bottom yeasts use 2 to 3 per cent for respiration and ferment the rest The metabolism, if one takes into account the energy values of both respiration and fermentation, was found to be 43 per cent higher in the top yeasts Trautwein and Wassermann also found that while out of the total metabolism in top yeasts 40 per cent was respiratory and 60 per cent fermentative, in bottom yeasts the values under the above heads were 32 and 68 per cent respectively

These differences are significant enough but other differences are also on record It was shown by Bau in 1894 that top and bottom yeasts differ in their ability to ferment melibiose (Henrici, 1941) Bottom yeasts alone are able to produce gas from this disaccharide This division of industrial yeasts was confirmed by Stelling-Dekker (1931) using raffinose and quantitative methods She found that top yeasts like *Saccharomyces cerevisiae* ferment only one third of raffinose, while *Saccharomyces carlbergensis*, which is said to be a typical bottom yeast, ferments this sugar completely

Hansen discovered that by keeping flasks inoculated with *Saccharomyces turbidans* at a temperature of 0 5°C for a period of 3 to 5 months and later transferring them to fresh flasks at the normal temperature, this typical bottom yeast gave a top fermentation Among 150 cells which he investigated not one gave a bottom fermentation A study of 100 cells of the untreated *Saccharomyces turbidans* showed that while 50 per cent were of the top fermenting variety, the others were of the bottom type Other industrial yeasts of both varieties were, therefore, investigated by Hansen. When kept at 0 5°C for 4 months, the bottom types showed no growth while the top yeasts showed development Hansen obtained also some other evidences regarding this

transformation Among 1,000 cells of the race Johannisberg II, 984 gave bottom fermentation and the rest 16 intermediary fermentation On further investigation, out of 100 cells from the above 16 colonies, 5 were of the top, 55 of intermediary and 40 of the bottom types Even the 5 cells of the top variety when tested segregated into 78 top, 9 intermediary and 13 bottom varieties (Guilliermond, 1920, pp 186-187) By substitution of ascospores for vegetative cells no difference was observed and *Saccharomyces carlbergensis* and *monacensis* presented an identical behaviour

On the other hand, reversal of top yeasts into bottom ones was observed by Hansen only in a few doubtful cases Out of 100 cells of the top yeast, *Saccharomyces validus*, he could get only 3 bottom cells In another lot of 1,529 cells only one belonged to the bottom type Among 2,423 cells of the top yeast, *Saccharomyces cerevisiae* only 7 doubtful types of the bottom fermenting variety were observed

Winge and Laustsen (1939) never obtained top yeasts from bottom ones, but they obtained bottom yeasts from top ones by spore segregations Because some of the industrial yeasts failed to grow at 0 5°C Hansen thought that low temperatures had only a selective value, the top yeasts possessing the ability to multiply and ferment at low temperatures Since at ordinary temperatures some bottom yeasts produced top fermenting ones, Hansen (1905) thought that the transformation was spontaneous If one applies rigidly the ability to ferment melibiose as a vital specific or racial criterion, then, the concept of species and races itself in yeasts may have to be revised *Saccharomyces carlbergensis* may give rise to a mutant which may resemble *Saccharomyces cerevisiae* Hence it is that Winge and Laustsen consider that it is quite unjustifiable to use this character in separating types

Enormous advances have been made in the cytogenetics of higher plants since Hansen's time and ever since Randolph (1931) showed the effect of heat treatment on the developing zygote of the maize, the effect of heat and cold treatments have been extensively investigated It has been shown that not only does cold treatment induce polyploidy but like X-rays it may in some cases lead to chromosome breakage (Dermen, 1940) It is being increasingly realized that heat and cold treatments like colchicine and other polyploidizing agents may produce mutations apart from polyploidy Therefore, it appears likely that not all cells need react in the same manner to treatments intended to induce polyploidy It has recently been shown that the brewery yeast Sc 9 when treated for 90 days with acenaphthene produced a polyploid (Subramaniam, 1945b) as well as a top yeast as a mutant (Subramaniam and Ranganathan, 1945b). A flask culture of the control Sc 9 kept in the ice room for 3 months showed two distinct types of cells, small and large, the former forming a layer at the top Hence, if one may take the liberty, it is possible to interpret Hansen's observations in a different manner There appears to be some justification for the above procedure, since Winge and Laustsen (1939) conclude that the character responsible for the differentiation into top and bottom yeasts appears to be of a quantitative nature

Admittedly it is difficult to conceive that all top yeasts have an identical origin or an identical chromosome constitution And since the only top yeast investigated cytologically is the mutant which appeared in our cultures (Subramaniam and Ranganathan, 1946) the explanation of the transformation of bottom into top yeast and the segregation of the latter into bottom and top types can only apply with full force to the particular strain in question

The control strain Sc 9 (N C T C 3,007) is a bottom fermenting type It is labelled in the National Collection of Type Cultures, India, as *Saccharomyces cerevisiae*, strain Sc 9 The question of its identification itself will have to be settled The cells of this particular strain have two equal chromosomes (Subramaniam and Ranganathan, 1945 , Subramaniam, 1945a) The mutant on the other hand appears to have lost a bit of one of the chromosomes (Subramaniam and Ranganathan, 1946) Loss of a bit of a chromosome has thus converted a bottom fermenting yeast into a top fermenting one Deficiency of a part of a chromosome has been noticed previously in *Drosophila, Matthiola* and

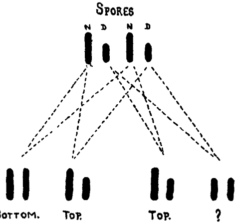

FIG 1

Crepis (Darlington, 1932). Eigsti (1939) has recorded breakage of chromosomes in pollen tubes of *Polygonatum commutatum* treated with colchicine The cells of the mutant are smaller and if a 24 hour

wort culture is examined, the cells are found to form a layer at the top. If slightly shaken, flocculent masses may be seen to settle slowly at the bottom. If well shaken and the cells uniformly distributed in the medium, their settling property as compared with that of the control and the tetraploid appears to be poor. On agar slants, this mutant forms spores, and if a tube of wort is inoculated with such a spore-containing sample a 24 hour culture shows two layers, one at the bottom and the other at the top. Naturally the spores can have only either the normal (N) or the deficient (D) chromosome. Since these spores, or the haploid cells originating from them, have to fuse before giving rise to the diploid, the result would be that 25 per cent would be bottom yeasts and 50 per cent top yeasts (Fig. 1). The fate of the other 25 per cent can only be stated after extensive experiments. The bottom yeasts thus obtained should behave like the typical control provided no crossing over has occurred (Winge, 1944) and if acenaphthene treatment has produced no gene mutations in the normal chromosome. The above explanation would bring into line the curious observations of Will and Jorgensen (Guilliermond, 1920, p. 186) on industrial scum yeasts and of Hansen on the mutant of Johannisberg II.

It is quite likely that different top yeasts may have entirely different origins. But experiments on the mutant in question may enable one not only to test whether the bottom yeasts lose their ability to ferment particular sugars as a result of mutation, but also whether the loss of a bit of a chromosome increases their respiratory rate and whether, if at all, they have any economic importance, since, top yeasts are being used in Europe and America in breweries, distilleries and in the manufacture of baking yeasts.

Incidentally a well planned investigation on the physiology of the above mutant may furnish proof to clarify not only the question of criteria to distinguish species and races in yeasts, but may also enable the location of some of the genes in the chromosomes at some future date.*

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* I am very grateful to Sir J. C. Ghosh, Kt., F.N.I., for his active interest and encouragement.

HELMINTHOSPORIUM DISEASE OF PADDY IN BENGAL

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THE discovery of the *Helminthosporium* Disease of paddy dates as far back as in 1895, by Miura, though the investigator ascribed a wrong name to the causal fungus Researches of the subsequent workers have thrown more light on the nature and symptoms of the disease as well as the morphological behaviour of the causal organism *Helminthosporium* disease of paddy caused by *Helminthosporium oryzae* Breda de Hann has since been known in all the countries wherever paddy is grown and attempts to find out suitable control measures have been made, though with little pronounced success

In Bengal the disease has been found to occur more or less every year in mild form but it is only since 1942 that serious attention has been paid to it as the paddy crop during that season sustained an unprecedented injury due to an epidemic of the disease in severe form Prior to that the loss due to the disease was regarded to be insignificant as compared to "Blast" or "Ufra" diseases of paddy

The disease is found every year throughout Bengal more or less in all the varieties of paddy—the late varieties of paddy being more susceptible

What follows are some of the observations of the writer in connection with the investigations into the diseases of paddy in Bengal for the last three seasons

NATURE OF THE DISEASE AND THE DAMAGE CAUSED BY IT

The disease appears first on the leaf blades and the leaf sheaths in the form of small brown spots The spots gradually enlarge and are dark brown in colour Several spots may coalesce but the outlines of the individual spots are often marked In ordinary seasons the flag leaves together with a few grains in the earheads are affected. But in the severe form of attack the whole earhead becomes brown to black and scarcely emerges out of the flag leaf When the disease appears early in the seed bed, it causes a great damage to the seedlings, the severely infected ones of which die out completely It has often been found that the roots of the diseased plants get decomposed but it cannot be said with definiteness whether the rotting of the roots is due to the direct effect of the *Helminthosporium* disease or not

Hence the damage due to the disease is fourfold, *i e*, (1) Non-germination of the seeds, (2) Death of the seedlings, (3) Weakening of the entire plants, and (4) Non-emergence of the earheads or non-development of the grains

The damage in the last form, when it occurs, is the greatest.

SOURCE OF INFECTION

It has been claimed by a number of workers that the disease is seed-borne. Though there should be no doubt about the claim, a relevant question that spontaneously arises in this connection and which still remains unanswered, is—"How far is the diseased seed responsible for the spread of the disease in the grown up plants?" It is very common to meet with the disease in a field inspite of carefully picked up healthy seeds being sown It is also not rare, on the other hand, to find a fairly large number of healthy seedlings out of heavily diseased seeds sown in the fields A study of the development of the disease from the germination of the seeds to the earing stage of the plants in pots has given the following data It is to be noted that heavily diseased seeds were used in the experiment and each individual seedling was kept under observation for a period of 125 days. (Table 1)

TABLE 1

DEVELOPMENTAL STUDIES OF THE *Helminthosporium* DISEASE OF PADDY FROM GERMINATION OF THE SEEDS TO THE EARING STAGE OF THE PLANTS IN 5 VARIETIES OF *Aman* PADDY

(1) Variety	(2) Number of seeds sown (10 per each pot)	(3) Seeds not germinated	(4) Seedlings died within 20 days from germination and removed from the pots	(5) Coleoptile discoloured but the seedlings have survived	(6) Plants with leaf spots	(7) Plants with ear infection (just a few in each earhead)	(8) Seedlings died due to attack of *Curvularia lunata*	(9) Plants apparently free from any disease
Latisail	100	13	9	6	16	7	8	41
Kumergore	100	42	16	5	9	4	4	20
Asra	100	26	20	3	17	2	1	31
Patnai 23	100	16	5	4	12	5	5	53
Nigersail	100	22	15	2	5	6	7	43

From the above data it is clear that a large proportion of plants remained healthy throughout, though they have come out of heavily diseased seeds It is also interesting to note that some of the seedlings died due to an attack of *Curvularia lunata*, the constant association of which with *Helminthosporium oryzae* will be discussed later in this article

Further, an experiment was conducted at Dacca and Chinsurah in the year 1944, on the following lines Different grades of diseased seeds, *i e* , 10%, 30%, 50%, completely diseased and absolutely healthy seeds were used. These 5 treatments were randomized in 6 replicated blocks in the field Monthly observations were taken counting the number of diseased plants and on the intensity of infection per individual plot, taking into account both the leaf spots and the ear infections The result of analysis of the data did not show any significant difference in the number of diseased plants as well as in the amount of intensity of attack, expressed as percentage to the total between the treated ones and the control In other words, the results of the experiment add one more evidence to our observations that the role of the seed borne infection is of little significance in the incidence of the *Helminthosporium* disease of paddy in the latter stages of growth of the plants

The question that arises next, out of the above inferences is—What then is the source of infection in the later stages? This is a question that has confronted almost all the workers in the line and no satisfactory answer has yet been forthcoming We may summarize the possible sources of the fungus as follows :—

1. Primary sources of infection—
   (*a*) Diseased seeds
   (*b*) Mycelium or conidia viable in the soil till the next season
   (*c*) Spores or mycelium from the diseased plants remaining mixed up with soil in the field
2. Secondary sources of infection—
   (*a*) Conidia from the diseased seedlings standing in the field.
   (*b*) Conidia or other kinds of spores from the alternate or secondary hosts, if any.

As regards the diseased seeds as the source of infection, this point has already been discussed As regards the other two sources of primary infection, their possibilities cannot be overruled by the fact that samples of soil collected from the fields have shown that the conidia may remain viable throughout the winter and the next summer till the next crop is sown, in a desiccated and shortened form ' But though the viable spores in the soil can infect healthy seedlings through the roots or the collar region, this does not explain how the localized leaf-spots and the sporadic ear infections are produced in the later stages

Alternate or secondary hosts of this fungus have not been definitely found out in nature, though a large number of grasses can be successfully infected by *Helminthosporium oryzae* by artificial inoculations Nishikado and Miyake (1922) reports that some 50 species belonging to 30 genera were found susceptible to the fungus During the last 3 years we have collected as many as 37 species of gramminaceous and cyperaceous weeds from the paddy fields of different parts of Bengal, but failed to isolate *Helminthosporium oryzae* Breda de Hann, from any of these species

How far the conidia of *Helminthosporium oryzae* are wind borne?

An experiment was conducted at Dacca during the last season, in which the following method was adopted A set of greased slides were fixed in each of a number of vertical wooden frames, 5 ft in height The slides also were placed vertically at different levels and the frames were placed, inside the plots with paddy plantations as well as at a distance from the plots, the greased side of the slides being exposed to wind It has been observed that the deposit of conidia on the slides placed inside the plots, is limited to a height of 2 ft 6 inches only and is very insignificant in number No conidia were deposited on the slides placed at a distance of 20 ft. from the plots It is thus very apparent that the conidia are not carried by the wind to a long distance and this eliminates the possibilities of a source of infection from alternate or secondary hosts from a long distance

An estimate of the actual loss due to *Helminthosporium oryzae*

A proper estimate of actual loss due to *Helminthosporium oryzae* is extremely difficult owing to the fact that the symptoms of *Helminthosporium oryzae* and that of *Curvularia lunata* on the leaves and the earheads are hardly distinguishable and the two fungi seem to be universally present side by side, thus masking the symptoms of each other From our observations extending to 3 successive seasons we could not differentiate the symptoms of one clearly from the other and this has rendered the collection of data on the *Helminthosporium* disease alone, very difficult.

In order to differentiate the symptoms of *Helminthosporium oryzae*, *Curvularia lunata* and

Trichoconis caudata, on the grains of paddy, the following experiment was carried out in the laboratory

3 sets of diseased seeds were separated out according to the symptoms noted below —

A Grains empty, with a purplish brown discolouration having a considerable pale white area demarcated either at the centre or at one side of the grains.

B. Brownish discolouration on the grains becoming pale and dull grey in colour

C Deep brown spots or discolouration becoming black at maturity.

Seeds were surface sterilized and placed in moist chambers The observations are tabulated below (Table 2)

TABLE 2

STUDIES ON THE DIFFERENTIATION OF SYMPTOMS PRODUCED BY *Helminthosporium oryzae*, *Curvularia lunata* AND *Trichoconis caudata* ON THE GRAINS OF 6 VARIETIES OF PADDY (500 seeds of each variety tested)

(1) Variety	(2) Type of symptom	(3) No of grains with *H oryzae*	(4) No of grains with *C lunata*	(5) No of grains with *T caudata*	(6) No of grains with *Fusarium* or *Penicillium*	(7) No of grains without any infections
Latisail (Amon)	A	10	nil	270	25	195
	B	140	145	35	95	85
	C	303	31	29	37	100
Kumergore (Amon)	A	28	57	169	103	143
	B	48	117	5	98	232
	C	66	69	8	57	300
Patnai 23 (Amon)	A	29	19	347	23	82
	B	94	132	15	41	218
	C	206	43	21	16	214
Asia (Amon)	A	42	62	249	25	122
	B	35	144	17	49	255
	C	165	25	26	32	252
Nijersail (Amon)	A	31	25	196	80	168
	B	12	155	36	16	281
	C	215	29	69	nil	187
Dhanal (Aus)	A	106	89	165	45	95
	B	42	233	40	26	159
	C	310	44	15	30	101

From the above it may be seen that no one type of symptom is exclusive of a fungus

CONTROL MEASURES

All past experiments and suggestions regarding control measures have centered round the single accepted proposition that the *Helminthosprium* disease of paddy is a seed borne disease and the researches have been directed towards treating the seeds with different chemicals and hot water with which several workers have claimed to have obtained good results

During the years 1944-45 and 1945-46, experiments were conducted at Dacca with heavily diseased paddy seeds, treated with chemicals such as Agrosan G, Formalin, Sulphur, Baluchistan Sulphur and Copper carbonate There were in all 5 treatments and a control and the experiment was carried out on an ordinary 6 by 6 Latin Square design The results of analysis of variance do not show any significant difference in the number of diseased plants expressed as percentage to the total, between the treatments and the control The treatmens are also found not to have produced any significant difference in the yield of grains In other words, the experiment indicates that seed dressing with chemicals, as mentioned above, has no effect on the incidence of *Helminthosporium* disease of paddy. Seed dressing has also got no bearing on the yield of grains.

Researches have indicated that the hot water treatment is the best remedy for the seed borne infection of *Helminthosporium oryzae*. But, as we have pointed out previously, the diseased seeds are only partly responsible for the incidence of the disease in the grown up plants. Seed treatment, therefore, is not likely to produce a desired effect to check the secondary infection. We are not yet in a position to say with definiteness as to whether there

exists any secondary or alternate host of *Helminthosporium oryzae* or not, but it seems almost certain that the secondary source of infection is more important than the primary one for the epidemic that may be caused by the disease in some of the seasons having adverse climatic conditions

The disease is very sporadic in its nature and does not break out in regular intensities every year Besides other factors, adverse climatic conditions, that favour the plant diseases in general, such as continuously heavy showers, cloudy and foggy weather together with a moderately high temperature of the season, seem to be favourable to the *Helminthosporium* disease of paddy.

So the only plausible method for controlling the disease will be by way of finding out suitable varieties of paddy, resistant to the different strains of the fungus (Some biologic forms of *Helminthosporium oryzae* have been claimed to have been established by Tochinai and Sakamato, 1937) Work on this line is in progress in the Department of Agriculture, Bengal Out of 44 varieties tested during the last season, *Dahar Nagra* 273-32, *Patnai* 549-33, *Patnai* 23, *Kalma* 219 and *Nagra* 41-14 have been found to be more resistant to *Helminthosporium oryzae* than the rest of the varieties, of which *Kalamkati* 147 and *Bhasakalma* are the most susceptible It is intended to publish a detailed account on the varietal resistance to the *Helminthosporium* disease of paddy later on.*

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* My sincere thanks are due to Khan Bahadur Dr S Hedayetullah, Economic Botanist to the Government of Bengal for kindly going through the manuscript and for valuable criticisms

Notes and News

INTERNATIONAL CONTROL OF ATOMIC ENERGY

A Report on the International Control of Atomic Energy, a U. S Government publication (reprinted by H. M. Stationery Office), embodies the views of a committee on Atomic Energy of which D E Lilienthal, of the Tennessee Valley Authority is the chairman. The report is to be presented to the U.N.O. commission on Atomic Energy

The plan presented herein is based on three basic axioms: (1) that no adequate control could be achieved by any system of international policing alone and unsupported by other measures, (2) that it is essential that an absolute international control be maintained on uranium and thorium and (3) that an International Atomic Development Authority (A.D.A.) be set up, charged with the twofold duty of maintaining security and vigorously promoting beneficent developments or usage of atomic energy.

All activities concerned with atomic energy can be classed as either 'safe' or 'dangerous' and one of the duties of the A D.A would be to re-draw the dividing line between the two from time to time. The 'dangerous' activities would include the mining of uranium and possibly thorium and the production of uranium 235 and plutonium. 'Safe' activities include the use of small piles for producing radio-active materials for research in physics, chemistry, biology or therapeutics, and the operation of power piles using only denatured plutonium. Irrespective of intentions, dangerous activities would be forbidden to all except the A.D A and A D A. as sole owner of stocks would supply the denatured 'fuel' for these piles

The Lilienthal committee further recommends that the uranium 235 and plutonium plants of the A.D.A. would be established so as to preserve the strategic balance between nations. But safe activities would be permissible for national States or even private corporations, subject to certain licensing conditions and to inspection by the A.D A.

The A D A will thus have a series of functions to perform surveying, control and working of uranium and thorium, the operation of isotope separation plants and plutonium-producing piles, half of the production of atomic energy, and above all very great obligations in research and development

Since then an Atomic Energy Control Commission has been appointed by President Truman, consisting of Dr Robert F Bacher, physicist, Cornell University, Mr David E Lilienthal, former head of T V A , as chairman, Mr Summer T Pike of Maine, Mr Lewis L Strauss, banker, New York and Mr William W Waymack, editor, Iowa

Under America's Atomic Energy Law they take over all atomic weapons, atom-splitting materials and equipments and take up responsibilities as great as men have ever assumed in peace time

An 'Atomic Energy Bill' was introduced in the House of Commons on May 1 last The bill was presented by the Minister of Supply, who should be able to control all activities concerned with the production of atomic energy. The bill further provides that it will be an offence to disclose information about atomic energy plant without the permission of the minister Atomic energy is defined in the bill as "the energy released in any process, including the fission process, which involves the transformation of/or reactions between atomic nuclei and has been influenced by special arrangements of matter or by other applied means, but does not include energy released in any process of natural transmutation or radioactive decay which is not accelerated or influenced by external means"

The bill is likely to affect fundamental research in nuclear physics and allied subjects and really first-class scientists are likely to change over to other subjects or to other countries where the 'secrecy' clause does not apply The gloomy aspect of a scientist's chances of survival if he adopts this branch of research is reflected in a cynical joke 'I reckon there is a 33⅓ per cent that I shall die of leukemia, a 33⅓ per cent chance that I shall die in an atomic bomb explosion and there is an equal chance that I shall end up in goal!'

The bill has not made it clear that the government seeks to promote the use of atomic energy for peaceful purposes with the least possible delay

ATOMIC SCIENTISTS' ASSOCIATION

An association has been formed of scientists who are connected with atomic energy projects in Great Britain, Canada and the United States The aims of this new organization are

1. To provide a forum for the discussion among scientists of the scientific, social and international problems arising out of the release of atomic energy.
2. To keep these problems before the public and to press for a positive political programme for their solution
3. To disseminate and explain published material on atomic energy and particularly on its implications both to other scientists and to the general public Also to provide an agency for the counteracting of misleading statements

A provisional committee has been set up consisting of Prof H S W Massey (Chairman), Dr W J Arrol and Dr E H S Burhop (Joint Hon Secretaries), at the University College, Gower Street, London, W C 1

One of the tasks confronting this association was to study the most effective means of international control of atomic energy A memorandum for effecting this control is also released by this association, bearing the signatures of nineteen famous scientists, all of whom were engaged on some aspects of atomic research, during the war This is the most significant pronouncement so far made on the subject by scientists in Britain and is submitted to the United Nations Atomic Energy Commission (U N A E C) In many respects the conclusions reached by this association are similar to those of the American report, and some of the recommendations are

1. That an attempt be made immediately to obtain an international agreement by which the use of atomic energy, the distribution of the essential raw materials for it, and the erection and operation of plants designed for production of active materials be strictly controlled by the U N O
2. That this control be implemented by a system of inspection and the inspectors appointed on behalf of the U.N O. have the right of access to any place, plant or institution in any country for ascertaining that there exist no source of atomic energy, other than that approved by the U.N.O
3. That all major sources of raw materials and production plants be handed over to U.N O. and be operated by national contractors under international management boards and guarded by men of the U N.O.
4. The U N.A E.C. should undertake the construction and operation of new large-scale plant for the production of fissionable material and so distribute these plants that if any nation should seize control of the plants operating in an area in which its own

armed forces are predominant, the remainder of the United Nations would jointly maintain an overwhelming superiority in the production of fissionable material

5 That the disposal of active materials produced in such plants and the research, development and production of atomic explosives be reserved to U N O and all bombs be kept in stores throughout the world and operated as described under (3)

In the present state of world apprehension, it seems necessary that atomic bombs should be produced and controlled by an international authority When this authority would be functioning effectively, atomic explosives could then be used for peaceful purposes only

6 That as the scheme described above becomes effective the existing secrecy rules be lifted, with the release of all basic scientific information, and all research be carried on freely with a duty to report to U N O any significant results

7 That the free movement and interchange of all scientists working on atomic energy or otherwise be permitted

8 The committee support the recommendation of U S report, dividing atomic energy activities into 'safe' and 'dangerous' and an approach of this kind gives promise of an effective control of atomic energy developments with a minimum encroachment of the national sovereign rights of the nations

The need for international contact was stressed at a three-day conference of A S A , held at Oxford, in July 1946 in the presence of a number of visiting scientists from India and elsewhere (*Discovery*, September, 1946)

ATOMIC RESEARCH IN INDIA

An Atomic Research committee has been set up in India with Prof Bhabha as chairman and another unit is shortly to be set up under the Geological Survey of India and Dr M S. Krishnan would proceed to U.K in this connection This announcement was made in the Central Legislative Assembly at New Delhi, on November, 1 last by Mr G K. Gokhale, Secretary, Works, Mines and Power Replying to a question by Seth Govind Das asking for an assurance that atomic energy produced in India would be employed for constructive rather than destructive purposes, Mr Gokhale referred the matter to the defence department

ANDREW THOMAS GAGE (1871—1946)

Dr A. T. Gage, C I.E., M.A., B.Sc , M.B , C.M., LL.D. (Aberd)., F.L.S., I.M.S. (Retd.), Mem. Corr Soc. Nat. d'Acclim. de France, (a former Superintendent, Royal Botanic Garden, Sibpur and Director, Botanical Survey of India, 1904-1923), who died in England on the 21st January last belonged to that long established tradition of "medical man with a leaning towards Botany" Gage joined the I.M.S., in 1897 and soon after was appointed Curator of the herbarium (Sibpur) and lecturer in Botany, Civil Engineering College, Sibpur (Agricultural Department) In 1904, he succeeded the late Sir David Prain Kt , F R S , as Superintendent of the gardens and Professor of Botany, Medical College, Calcutta

Between 1898—1904, Gage explored the botanically unknown region of the South Lushai hills (*Rec Bot Surv Ind* 1, 1901) and the vegetation of the drier 'desert' zone of the District Minbu, Upper Burma (*Rec Bot Surv Ind* 3, 1904)

During 1909-1912, Gage surveyed the 270 acres of the garden, a map prepared and 14,000 plants growing in the garden indentified and labelled This led to the publication of a catalogue, Part 1 (numerical list) of trees, shrubs and climbers growing in the garden (*Rec Bot Surv Ind* 5, 1911-12), that facilitate exchange of seeds and plant materials required by institutions in India and abroad The second *i.e* , Part 2 (systematic list) of this work, giving fuller details of time or source of introduction, times of flowering, fruiting etc , as planned by Gage is yet to appear

Proposals to re-organize the Botanical Survey of India were submitted by Gage to the Board of Scientific Advice to the Government of India, in 1907-08 which resulted in the appointment of two systematic assistants Proposals were made again in 1918, involving a recurring expenditure of Rs 4,50,000 per year, that were accepted by the Government but very little effect was given to these and the survey has since then undergone a steady decline

In 1912, the office of the Reporter on Economic Products to the Government of India was abolished and the Industrial Section, of the Indian Museum was transferred under the Botanical Survey and Gage was appointed Officer-in-charge of this section.

Shortage of drugs during World War I, led to his undertaking investigation and experimental cultivation of various indigenous plants of reputed medicinal value, *e.g* , *Taraktogenos* (*Hydnocarpus*) *Kurzii*, *Gynocardia odorata* and *Hydnocarpus venenata* (for chaulmoogra oil in connection with leprosy investigation undertaken by Sir Leonard Rogers), *Bergenia purpurascens* (for the relief of dysentery), *Chenopodium ambrosioides* and *C anthelminticum* (source of oil for the treatment of hook-worm), *Lycopodium* (for supply of spores for coating pills) and a host of others.

As Superintendent of cinchona cultivation in Bengal, Gage held charge of the extensive Govern-

ment cinchona plantations in Bengal and Burma and was responsible for the manufacture and distribution of quinine and febrifuge throughout India Shortage of quinine during World War I, led the Government of India to depute Gage to survey the whole of India and Burma in 1917, with a view to discover new regions where cinchona might be successfully cultivated The report submitted by Gage in 1918 was accepted by the Government and the area on the flank of a tributary of the Hemze river in the Tavoy district in Southern Burma was selected and plantations made in 1921 Unfortunately, the site had to be abandoned due to an unexpected heavy rainfall of over 240 inches during June-August, and for want of proper drainage more than half the plants succumbed Another site further south (Mergui) was then chosen but here again the plants wilted and died due to a mysterious collar disease Efforts were made to make the enterprise a success but the plantation had eventually to be abandoned in 1936. These enterprises involved enormous loss of money to the Government but had the results been otherwise, the cinchona problem in India would have been solved

Gage published few papers on Systematic Botany. The most noteworthy of these deal with the Indian Polygonums (*Rec Bot Surv Ind 2*, 1903) and the Euphorbiaceae (*Kew Bulletin*, 1914) The latter work he completed at the Kew Gardens, while he was on study leave (1913-14) Later in 1922, he published a paper on the Euphorbiaceae of the Eastern Malayan Peninsula (*Rec Bot Surv Ind 9*) Decline in the activities of the Botanical Survey under Gage, may partly be accounted for by the World War I and its aftermath and partly by the increase in the administrative work regarding cinchona operations

Gage was elected General President, Indian Science Congress (1922-23) but he could not preside at the 10th sessions of the Congress at Lucknow as he went on leave preparatory to retirement from 3rd January, 1923 Earlier in 1916, he communicated a paper on 'Some irrational aspects of Systematic Botany' (*Proc 3rd Ind Sc Cong*) wherein he discussed the problem of synonymy in taxonomy. Gage was for many years an Ordinary Fellow of the Calcutta University, a member of the Board of Trustees of the Indian Museum since 1906 and Secretary of the Board of Scientific Advice to the Government of India since 1903

In 1924, Gage was appointed to the newly created post of librarian and assistant secretary (as a helping hand to the 80 year old General Secretary, the late Dr B D. Jackson) of the 'Linnaean Society of London'. He had however to resign the post in 1929 for reasons of health. During these years, he interested himself particularly in the archives of the society and he was asked by the council to prepare a history of the society which was published in 1938, to mark the 150th anniversary of the foundation of the Society

COAL INDUSTRY AND TRADE

PRESIDING at the 22nd Annual General Meeting of the Geological, Mining and Metallurgical Society of India, held at Calcutta on the 18th October last, Dewan Bahadur D D Thacker (the retiring president) dealt with problems affecting the utilization of India's low grade coal and the problem of high grade coal suitable for metallurgical purposes

The total estimated reserve of coal in India is about 87,000 million tons which represents 1 1 per cent of the world's total reserve Out of India's total, 20,000 million tons of gondwana coal and 2,300 million tons of tertiary coal, is workable,—of this, 5,000 million tons are of good quality including 1,500 million tons of coking coal The present wasteful process as adopted in our coal mines enable to recover only 50 per cent of this By application of improved methods of mining 75 per cent can be recovered On the basis of our present-day average production and consumption, the life of our available reserve of coking coal is only 50 years without stowing and 75 years if sand stowing is fully resorted to

As India contains sufficient reserves of low grade coals attention should be given to manufacture good quality soft coke after picking out the impurities and to popularize it as a domestic fuel throughout India. With this is linked the problem of intensive research in coal The problem of high grade coal suitable for metallurgical purposes is even greater as the reserves of such coal are very limited, and it would be quite reasonable to demand that this coal should be conserved for smelting purposes.

Millions of tons of peat and lignite are being worked in Europe and America and it has been possible to make use of them Research in all directions on a vast scale should be carried out in India so that the low-grade coal can be more efficiently utilized. In England a new research station is to be opened at a cost of five million pounds whereas the Government of India has decided to spend Rupees fifteen *lakhs* only and that spread over in five years for the Fuel Research station at Dhanbad. If research work in all directions of coal research is to be carried out a more generous budget is required.

Sir S. N Roy, Coal Commissioner, who was the chief guest at the function also mentioned the problems of the coal industry and the need for research, to which all industrial countries now attach importance.

There was, he said, a shortage of coal in the country. India's estimated requirements were 35,000,000 tons, about 6,000,000 tons more than what she raised. Industrial expansion was being held up by lack of coal India has to rely mainly on her own resources and it was essential to make a survey of new fields, embark on a policy of conservation, develop other sources of power, undertake research and establish central machinery to co-ordinate all sources of power—electricity, gas, oil and coal

Stressing the need for research, Sir S N Roy said that, apart from government, private industries should also undertake and pay for it

The following were elected to the various offices for 1946-47 *President*—Mr Sushil Ch Ghosh, *Vice-Presidents*—Mr A H Pandya and Dr C S Pichamuthu, *Treasurer*—Prof P C Datta, *Joint-Secretaries*—Prof N N Chatterji and Prof N. L Sharma.

PLANT SCIENCES IN ANCIENT INDIA

"THE history of sciences written by Europeans, trace the beginnings to Greek or at best to Arab speculations totally ignoring the fact that the Arabs and the Greeks were themselves indebted to the Ancient Indians" thus observed Prof G P Majumdar presiding at the "Technical Sciences" section of the 13th session of the All-India Oriental Conference held at Nagpur, from 18th to 22nd October last

The beginnings of the relation between man and plants can be traced to the prehistoric finds discovered in different parts of India by the archaeologists The later Neolithic and Iron Age people were at least partly pastoral, lived in houses, wore clothes and derived their wealth from agriculture etc They were well acquainted with a number of plants and perhaps knew something about their life The Indus valley people were far more civilized and cultivated crops including wheat, barley, millet, dates, vegetables, melon and other fruits and cotton. We are justified in believing that they knew quite a lot about the general life history of plants useful to them, particularly their propagation and cultivation, thus laying the foundation of the science of plants and plant life *i.e.*, Botany.

The Vedic Indians were mainly an agricultural people. They practised medicine, laid out gardens and consecrated them for public use Agriculture, medicine, arbori-horticulture, developed to a great extent. In the Vedic literature we find a large number of terms used in the description of both external and internal parts of plants; a definite attempt to classify plants; evidence of manuring and rotation of crops for improving soil fertility and nourishing plants; knowledge of the manufacture of food, the action of light on the process and the storage of energy in the plant body.

In the post-Vedic India, there is evidence to show that Botany developed as an independent science on which were based the sciences of medicine (as embodied in the *Charaka and Susruta*), agriculture (as embodied in the *Krsi-samgraha* of *Parasara*) and arbori-horticulture (as illustrated in the *Upavana-Vinoda*) This science was known as the *Vrksa-yurveda* and later as *Bhesajavidya* in the Ayurvedic texts.

INTERNATIONAL VISITORS' RESEARCH STATION

IN a report to the Pacific Science Conference, Washington, D C, held in June, 1946, Dr Frans Verdoorn of *Chronica Botanica* and *Arnold Arboretum*, has discussed the problem of future planning for research in large tropical countries which is of considerable international interest

As an illustration of the aims and scope of such a biological station he refers to the 'International Zoological Station' at Naples created by Dohrn This large well-equipped laboratory and library was established chiefly to permit workers from all parts of the world to study the rich Mediterranean marine fauna and flora, and related biological and oceanographical problems from systematic, morphological, anatomical, physiological, biochemical and cytological points of view It is financed by grants from nearly all governments of the world, in exchange for free working space for a certain number of their promising biologists, many of whom have devoted to marine, fresh-water and alpine biology and ecology, to meteorology, to volcanology, etc

Treub as director of the Buitenzorg Botanic Gardens and later at Tjibodas on Mt Gedeh, rendered more or less the same service at Buitenzorg as Dohrn at Naples. Treub made Buitenzorg a large, informal, and truly international biological station, where foreign scientists from all parts of the world came to study the rich fauna and flora of Western Java. Scientists from all parts of the world have visited this station and have done more fundamental biological research there than in any other place of the Old or New World tropics Treub organized a laboratory for visitors, built a dormitory where scientists could live at Tjibodas and arranged for fellowships enabling visitors to go to Buitenzorg.

The International Visitors' Station as proposed by Verdoorn is to consist of a modern laboratory, a library, a social building (with a theatre for films and lectures), a dormitory, restaurant, etc The laboratory should consist of a director, a small number of resident scientists—all men of high standard and with

international experience and idealism and well-versed in local fauna and flora.

The aims of such a station will be to promote and guide research of a special nature by visiting scientists, for the less specialized workers a course in tropical biology will have to be organized; for the ordinary tourist a short course have to be developed. Such an organization will be economical and an easy way to promote the study of flora and fauna of the tropics; it would be a cheap way of creating international goodwill among the countries concerned, and lastly for the development and reconstruction of the larger tropical areas a great number of scientists is needed who must be good scientists and the Visitors' Research Station will help in providing the personnel.

On the location of such a station, Dr Verdoorn suggests at Buitenzorg, Calcutta, Peradeniya, Manila, etc, where one finds a large number of scientific institutions. Certain activities may be moved to a higher altitude.

The general argument has been developed with reference to a biological station but similar work could be extended to all science subjects where field-work is important e g, agriculture, anthropology, archaeology, astronomy, chemistry, climatology, ethnography, geology, geography, geodesy, hydrology, mineralogy, oceanography, physiology, medicine, technology, veterinary science, volcanology etc.

We are indeed grateful to Dr Verdoorn for having emphasized the need for international research stations in the tropics and at a time when India is planning her future programme of scientific work. The details and the financial implications have yet to be worked out. But we have no doubt that the establishment of such a station in India (Calcutta, as suggested by Verdoorn) will no doubt help to promote research in subjects of special interest to the tropics.

ADVISORY PLANNING BOARD FOR INDIA

THE Advisory Planning Board, recently set up by the Government of India, held its inaugural meeting at New Delhi, on November 3 last under the chairmanship of Sj K C Neogy.

The terms of reference of the Board are (a) to review planning that has already been done by the Central and the Provincial governments as well as work of the National Planning Committee, appointed by the Indian National Congress and other plans and proposals for planning; (b) to make recommendations in the light of this review for co-ordination and improvement of planning; (c) to make recommendations as regards the objectives and priorities; and (d) to make recommendations regarding the future machinery of planning.

The members of the Board include Sj K. C Neogy, M L A (Central) *Chairman*; Dr Zakir Hussain, Nawab Ali Nawaz Jung, Mr Gaganvihari Lal Mehta, Mr Shoaib Qureshi, Prof M N Saha and Prof K T Shah (*non-officials*); Dr Nazir Ahmed, Sir S S Bhatnagar, Sir P H Kharegat, Mr H. K Kripalani, Mr E P Moon, Mr V. Narahari Rao and Mr S A. Venkataraman (*Officials*). Mr Moon and Prof Shah will act as *Secretary* and *Honorary Secretary* to the Board respectively.

Several sub-committees, *viz*, (1) Industries and Agricultural, (2) Future Machinery of Planning; (3) Finance and Irrigation were appointed by the board which would examine the various schemes of planning.

The board as a whole will re-assemble on December next and will be in session until Christmas.

The work of the Board is expected to be of a temporary character for the present but it may later be absorbed in a wider and more permanent organization.

ANNOUNCEMENTS

DR WALI MOHAMED, head of the Physics Department, Lucknow University, has been appointed Vice-Chancellor, Osmania University, Hyderabad. Dr Mohamed took charge of his office on the 16th October last.

The Sir Ramlinga Reddy National Prize of Andhra University for 1946 will be awarded this year to Lt Col Sir S S Sokhey, Director Haffkine Institute, Bombay and to Sir S. S. Bhatnagar, Director, Board of Scientific and Industrial Research, Delhi.

The Overseas Science Research Scholarship for 1946 has been awarded by the Royal Commission for the 1851 exhibition to Mr G N I. Ramchandran and Mr K R Surange for research in physics and in plant morphology and paleobotany respectively, at the University of Cambridge.

SCIENCE IN INDUSTRY

LAMINATED SKIS

TILL recently skis used in this country were mostly imported from abroad, the skis being usually made of ash or hickory With the advent of the war, imports of foreign skis almost stopped while their demand increased as they were also required by the Defence Services To meet this demand experiments were carried out at the Forest Research Institute on the production of laminated skis with considerable success

The results of the experiments carried out at the Institute on the fabrication of laminated skis which are better than solid wood skis in many respects are laminated skis made from *Dalbergia sissoo* and *Artocarpus hirsuta* using water resistant phenolic adhesives

In view of the encouraging results obtained it is hoped that production of laminated skis from Indian timbers will be taken up by firms manufacturing sporting materials (*Indian Forest Leaflets*, No 79 utilization)

FODDER TREES IN INDIA

THIS list of fodder trees is an useful supplement to the existing list of fodder grasses and general fodder supplies prepared by the Animal Husbandry Wing of the I C A R The list presented is the consolidated opinion of forest officers throughout India regarding the relative suitability of different tree species for lopping for fodder It will be necessary to select from the list of trees which, besides being good fodder trees are of vigorous habit and are likely to yield high percentage of fodder and above all are suitable to the climate and soil of the locality where it is proposed to grow the fodder plantations The list is fairly complete and the Silviculturist invites suggestions for alterations or additions to the information, so that a more accurate and complete edition may be published

The fodders are classified in this list as good, medium, and poor with remarks as to their suitability for particular class of animals. About 100 species are listed as good and include species of *Ficus*, *Quercus*, *Zizyphus*, *Morus*, etc (*Indian Forest Leaflet*, No 82, Silviculture)

JUTE SUBSTITUTES

BENGAL's monopoly of jute is likely to be endangered according to a report of the Indian Central Jute Committee, *Economic Research Bulletin, No 2*

Compared with its close competition, *e g*, bast fibres of *Urena lobata*, mesta (*Hibiscus cannabinus*), roselle, bhendi, *sida* and sunnhemp, jute is generally superior being relatively finer True hemp and flax, on the other hand, are best fibres that are definitely superior to jute as regards strength and durability Ramie is also far superior to jute in strength but it is not considered as a serious competitor as its uses are very different

Of the 'leaf' fibres, that are listed as jute competitors mention is made of sisal (a 'hard' fibre, as opposed to jute a 'soft' fibre), manila, caroe, *sansevieria* and *phormium*, etc, that are suitable in the manufacture of ropes and cordage There is a growing teendency to use such fibres in the production of bags and the threat to jute is obviously considerable

Jute competitors are classified as (1) fibres which may be grown in India and may be spun on jute machinery, *e g*, mesta, roselle and *urena*, (2) fibres which can be produced in India but can not be spun on jute machinery, *e g*, cotton, coir and sisal, (3) fibres which are neither produced in India nor suitable for jute machinery, *e g*, long-staple cotton, good quality flax, sisal and manilla, (4) fibres not produced in India but more or less suitable for jute machinery, *e g*, true hemp True hemp must be considered as one of the most serious potential competitors of jute, as it possesses greater strength and durability than jute fibre and its development in Russia will be watched with interest

War-time needs also encouraged much use of sisal, extensively grown in Africa and South America but the difference in price has not so far threatened the position of jute Intensive research, both agricultural and marketing is now required if jute is to maintain an assured future.

UTILIZATION OF LOW GRADE INDIGENOUS RAW MATERIALS FOR METALLURGICAL INDUSTRIES*

M V WAZALWAR

INTRODUCTION

THE subject is one of great national importance in the industrial development of India For a country of the size and population of India our mineral resources, though deficient in some essential metals, can be said to be fairly adequate No country in the world is self-sufficient in all minerals There is, therefore, a tendency on the part of every country to attain as high a degree of self-sufficiency as possible and at the same time to exchange its surplus minerals or mineral products for those ones in which it is deficient The policy of self-sufficiency is found by experience to lead to economic nationalism which in its most aggressive form could, of course, be found in countries pursuing a totalitarian creed In attaining self-sufficiency, low grade ores which could not be economically worked due either to the smallness of the deposits or the poorness of the quality of ores have naturally received more and more attention In this respect Germany led the way and other industrial nations had to follow suit For a while it seemed as if the U S S R was not so mindful of the technological advances in the mineral field, but Soviet Russia has proved that this impression was wrong

Mineral technology has made tremendous advances during the last decade Among the democratic countries Great Britain, U S A, France, Canada, Australia and South Africa have made considerable progress but India is still backward

World War II brings to the forefront the problem of utilizing in the best way possible the low grade ores of a country

To be profitably worked, an ore must command a certain minimum price It is our sad experience that so far, in peace times, even our high grade ores have fetched very low prices because we had largely to depend on foreign consumers, the metal industries in India not having developed sufficiently Also no attempt has been made to process the indigenous ores in the country before export so as to get a better return

PLANNING AND MINERAL DEVELOPMENT

The mineral deposits of a country being a dwindling asset, in tackling the problem of the utilization of low grade ores it is to be assumed that these ores are to serve the purpose of a definite plan* of industrial development, superseding the old policy of *laissez faire* An all India mineral policy should be laid down and it must provide for.

(a) preparation of a catalogue of all mineral occurrences ;

(b) estamates of the total reserves according to the various grades of ores ;

(c) earmarking those that are to be used for internal industries and those that are to be sent abroad, in the processed, or unprocessed state, in exchange for minerals which India needs ,

(d) mining with a view to conservation, *i.e* , avoiding loss and wasteful methods of mining, and *working the low grade ores along with the high grade* ,

and (e) beneficiation and marketing

In order to bring the low grade ores in the realm of economic working, the question of stabilizing and, if necessary, fixing the minimum prices for the ores will have to be given careful and thorough consideration So far the above points have received little attention

India has abundant reserves of iron ore, ilmenite, bauxite, magnesite, chrome ore (of all grades), manganese ore (of all grades), clays, kyanite, sillimanite, limestone and dolomite She has limited reserves of good quality coal, mica, copper, gold, beryl, sulphur, fluorspar, vanadium and very little tungsten, lead, zinc, uranium, arsenic and bismuth, and has practically no nickel, cadmium, boron, molybdenum and tin.

BENEFICIATION AND INDIAN ORES

The data below show the minimum percentage of the metal that should be present in the low grade ore to be brought up to the average required for use in the metallurgical industries

Beneficiation involves many technical and economic factors and necessary data have to be collected relating to

(1) character and size of the deposits,

(2) conditions affecting mining,

* Contributed to the Symposium held at the joint meeting of the sections of Engineering and Metallurgy, Chemistry and Geology and Geography of the Indian Science Congress, 1946.

* It is to be hoped that the Mineral Development Advisory Board newly set up by the Government of India will address itself to the task without delay

(3) metallurgical value of crude ore and possible concentrate,

and (4) marketing and other commercial considerations.

DATA ON METALS AND THEIR ORES

Metal	Tenor		Unit of measurement
	Low grade	Average	
Gold	2 00	5—12	$/ton
Silver	10	12—30	oz/ton
Platinum	3	4—8	dwt/ton
Iron	30	40—60	%Fe
Copper	0 8	1 5—5	%Cu
Lead	5	6—10	%Pb
Zinc	3	10—30	%Zn
Tin	1	1 5—5	%Sn
Nickel	1 5	2—3	%Ni
Aluminium	30	55—65	%Al_2O_3
Antimony	40	50—60	%Sb
Bismuth	By-prod	40—60	%Bi
Beryllium	10	10—12	%BeO
Arsenic	By-prod		%As_2O_3
Cobalt	5	8—10	%Co
Chromium	32	35—50	%Cr_2O_3
Cadmium	By-prod		%Cd
Manganese	35	45—55	%Mn
Mercury	0 5	1—3	%Hg
Molybdenum	0 4	1—3	%MoS_2
Titanium	3	4—8	%TiO_2
Tungsten	—	69—70	%WO_3
Vanadium	2	3—8	%V_2O_5

By A M Bateman, 1942

Assuming that an ore-body is either economically workable or is, of necessity, to be worked, the nature and amount of the impurities associated with the mineral determine the procedure that has to be adopted for beneficiation. The usual siliceous and clayey impurities can be easily got rid of while those in chemical combination need elaborate treatment Even then impurities like sulphur and phosphorus may be present in the ores to an objectionable extent from the metallurgical point of view

Beneficiation starts at the mine face where selective mining has to be adopted This is followed by simple methods like crushing, hand picking, jigging, screening, washing, water classification, table treatment, pneumatic separation Other methods are,—magnetic separation with or without preliminary thermal treatment, electrostatic separation, hydrometallurgical processes, agglomerating fine concentrates or in other words sintering them for blast furnace use, volatilizing, flotation and use of heavy solutions.

A flow sheet for a particular mineral ore may be evolved by adopting a suitable combination of any of the above methods and setting up a pilot plant in the first instance. There are few ore dressing problems that cannot be solved today and suitable equipment for any particular ore could be obtained from manufacturers in the U S A or the U. K.

In dealing with the problem of utilization of the low grade ores, associated with the better grades or occurring by themselves, the following important minerals may be considered .

Iron ore.—The bulk of the Indian reserves of high grade (60 per cent Fe) iron ore occur in Bihar and the E. S A. and have been reckoned at 4,000 million tons. The figure for the whole of India would be much higher but has not been computed. It may be assumed that for every ton of high grade ore, 4 to 5 tons of what is termed as low grade with siliceous and aluminous impurities (30 per cent to 50 per cent Fe) or unsuitable (powdery or friable) ore may be found, so that the total reserves of iron ore may be of the order of about 20,000 million tons, thus constituting the largest single mineral asset of the country. It will be wise to entrust the destiny of this ore in the hands of competent individuals or companies and corporations or the State itself It is impossible for small capitalists to compete in the open market and at the same time to work the mineral deposits by scientific and non-wasteful methods It should be more or less compulsory for the mine owners to work a certain proportion of low grade ore along with the high grade. Simple methods like washing the soft ores or sintering the powdery ores would considerably add to the output of a large mine

Additional smelting centres, large or small, could be located in Bihar and Orissa, the C P., South India, Rajputana and in the Punjab and U. P. Wherever possible electric smelting will have to be adopted to solve the fuel problem

Manganese—No reliable estimates of the total quantity of the various grades of ores are available. For a long time India has been a prominent exporter of manganese ore but the European and American consumers, having found nearer sources of supply, *viz*, Brazil, Chile, N. Rhodesia, S Africa, Gold Coast and the U. S. S R , are not now buying the Indian ore to the same extent as they were doing before Prior to World War II the manganese industry went through a most trying period of depression. Although huge profits were made during the boom period of the industry, covering a period of over 25 years, no serious attempt was made to improve the methods of mining or to treat the ores before export It may be pointed out that flotation methods have been lately perfected to beneficiate low grade oxide ores.

As most of the manganese ore is used for the manufacture of ferro-manganese, it has been long pointed out that this alloy should be manufactured in India in the first instance and then exported to foreign countries. This has not been done Instead

we are told that Indian ferro-manganese being high in phosphorus (0 55 to 0 66 per cent) will not find an overseas market. We know for a fact that certain manganese ores in the C. P, Keonjhar and Bonai States are low in phosphorus but the mine owners have not so far made it a practice to separate out the low phosphorus ores for the manufacture of ferro-manganese For every ton of high grade ore won in India, 3 to 4 tons of low grade ore are found Besides siliceous and clayey impurities (which can be easily removed), these ores are high in iron and phosphorus contents Highly ferruginous ores are not suitable for making ferro-manganese though they are good enough for the manufacture of spiegel A useful line of research would be to investigate how the iron and phosphorus contents of the low grade ores could be reduced It is necessary to know in what condition the phosphorus is present and to devise methods for its partial or complete elimination Giridih coal being particularly low in phosphorus has been strongly recommended by Sir L L Fermor to be reserved for use in the blast furnaces for the manufacture of ferro-manganese

Low phosphorus ferro-manganese could also be made in the electric furnace In the U S A electrolytic manganese is being produced from low grade manganese ores

Chrome Ore—High grade chrome ores (46% and above Cr_2O_3) should be conserved for the production of ferro-chrome Such ores are nearly exhausted in the Singhbhum chrome field but are expected to be found in fairly large quantities in Mysore, Keonjhar and Baluchistan In the Singhbhum chrome ore field, beneficiation of low grade chromite (with unduly high SiO_2 and FeO) should prove an easy proposition, but no attempt at scientific methods has so far been made If care were taken to beneficiate the low grade ore this field even now could supply the requirements of high grade and refractories grade of ores for the works at Jamshedpur for a decade or so Ores of Baluchistan and Ratnagiri could take care of the export trade and ores of Mysore, Singhbhum and Keonjhar could be reserved for internal consumption in the manufacture of ferro-chrome and refractory products It is imperative, however, that chrome ore occurrences of the whole of India should be thoroughly investigated and reserves estimated

Other alloying metals.—Of the important alloying metals, fuller investigations are necessary in the case of vanadiferous, titaniferous magnetites of Mayurbhanj and Singhbhum (research already progressing), ilmenite sands of Travancore, recovery of nickel from the copper ores of Singhbhum and cobalt from the Nepal and Khetri copper ores

The manufacture of ferro-silicon in Mysore and ferro-tungsten at Jamshedpur in the experimental stage has already proved a success We have abundant reserves of high quality quartz but India is very deficient in tungsten ore.

The phosphate ores of Singhbhum (16-20% P_2O^5) could be beneficiated and used for the production of ferro-phos

We have practically no deposits of molybdenum ; if necessary, it could be imported from Burma

Beryllium—Beryl, which forms the ore of Beryllium, has lately come to great prominence and the resources of this mineral in India are worthy of every consideration The mineral is found in Rajputana, Bihar and the Madras Presidency

Coal—The total reserves of all workable coals in India down to 1,000 feet are estimated at 20,000 million tons but reserves of good quality coals are strictly limited, *viz*, 5,000 million tons, down to 2000 feet depth Lately coal has been the subject of much discussion and although a good deal has been written and said about the wasteful methods of mining and the improper use of the coking coals (reckoned at 1,500 million tons without deducting loss in mining) in other than the metallurgical industries, no really effective steps have so far been taken to conserve it Sand stowing is still not compulsory in the coalfields and the railways are still consuming a large proportion, as much as 50%, of the coking coal that is raised annually We know that if the present state of affairs in the coal industry is allowed to continue we have not enough coking coal to last us for more than 40-50 years ; consequently the bulk of our iron ore reserves may not be smelted in this country With the development of thermal- or hydro-electric power, electric smelting of iron ore with the help of charcoal or inferior coals at suitably located centres would be a feasible proposition, but the cost factor will have to be carefully worked out. It is also likely that the State itself may intervene and put an effective stop to the use of coking coal (metallurgical coal) for steam raising and other purposes Scientific research may make it possible to add to the coking coal reserves by blending the coking coal with a certain proportion of low ash partially coking coals from the C. P., Singareni, Surguja and Korea coalfields It may not be beyond the capacity of fuel technologists to render the high sulphur coking coals of Assam low enough in sulphur for use in the iron and steel industry.

Very little success has so far been attained in the experiments carried out to determine the washability of Indian coals It is stated by E. R. Gee that the percentage of ash in certain seams of the Raniganj coalfield could be reduced by 4 or 5%

but the caking power could not be improved Ash being largely an inherent impurity in the coal itself, it remains to be proved that the flotation methods for cleaning coal would improve its quality both as regards its calorific value and caking power.

If research on the above lines is successful, India has no immediate fear of the exhaustion of her coking coal reserves. But the problem of shortage of coal will still remain. In the meantime smelting practice itself may change and coke may be replaced by other fuels For a large scale production not much importance can be given to charcoal as it will mean the exhaustion of our forests at a rate with which plans of afforestation may not keep pace

Use of pulverized fuel, hydrogeneration, low temperature carbonization, recovery of by-products and other allied problems will need sustained scientific investigation at the Fuel Research Laboratory to be set up at Dhanbad Successful research on these lines will result in the utilization of the inferior quality coals

Very recently the Government of India has set up a committee "The Indian Coal fields Committee" to advise on all problems relating to the coal industry

Sulphur.—India has been importing sulphur from abroad (Japan, Germany and Italy) In view of the key importance of this mineral in the chemical and metallurgical industries for the manufacture of sulphuric acid, it is highly advisable that every bit of it should be extracted from the existing resources in India Sulphur deposits occur at Sanni (Kalat) and Koh-i-Sultan in Baluchistan These deposits have been under active investigation, but we do not yet know how far they would be useful in peace times

Dr Dunn of the Geological Survey of India has stated that some sulphur could be available from the copper smelting operations at Moubhandar and has also suggested the recovery of sulphur from the large gypsum deposits of India. The deposits of iron pyrites at Banjari (Shahabad District) and Solan (Simla Hills), though small, need thorough investigation. Sulphur could also be recovered from the Tertiary coals of Assam and the Punjab

Fluorspar.—India is very deficient in this mineral and as it has its own use in the iron and steel industry, it would be wise to conserve its resources. The Rajputana occurrence (Kishangarh) has proved insignificant. The Chandi-Dongri occurrence in the Nandgaon and Khairagarh States, though small and of a low grade, could be beneficiated by flotation methods and the mineral used in the iron and steel industry in times of emergency The beneficiated ore that could be available may be 20,000 to 30,000 tons.

Refractory materials.—India is endowed with large quantities of refractory materials, the important ones being high grade quartzites, silica sands, fireclays, kyanite, sillimanite, bauxite, magnesite, dolomite, chromite, dunite, soapstone and graphite Silica brick and firebrick of very good quality are being made in India today, so also chrome brick, magnesite brick and chrome-magnesite brick Research on dunitic and talcose materials for the production of high quality basic refractories is in progress Such materials are found in Singhbhum, Mysore and Rajputana Unfortunately India has not made use of her world renowned kyanite deposits The sillimanite deposits of Assam still remain untapped

The use and manufacture of chromite, magnesite and chrome-magnesite as refractories has more or less come to stay in the country and India should not only meet her own demand for such refractories but also be able to export them in the near future.

Graphite has been found in the Eastern Ghats, in C P, Travancore, Kolar and Ajmer-Merwara In war time the mineral has been mined in the Patna and Kalahandi States Attempts have been made to manufacture crucibles from Indian graphite near Rajahmundry Graphite of suitable grade could be produced in India with the help of simple and small beneficiating plants

Moulding and silica sands are to be found in large quantities in India, particularly in the coalfields

Magnesite deposits of Salem and Mysore are world renowned The mineral also occurs in Idar and Dungarpur States, and Baluchistan A large proportion of the Indian magnesite production is exported The distance of the magnesite deposits from the smelting centres, however, raises the question of railway freights and concessional rates will have to be introduced by the Indian railways to enable its use at smelting centres in the northern, eastern and central regions Zircon from the Travancore sands has been separated and mostly shipped abroad for making very high grade refractories and ferro-zirconium It has been little used in the country

There is no doubt that, with the industrial development of India, the refractories industry could be one of the foremost in the country and this would necessitate considerable amount of research work, beneficiation and processing of the various raw materials of different grades.

Manufacture of aluminium.—Large deposits of high grade bauxite are found in India and particular mention may be made of those of the Baihar plateau, Balaghat district, Katni, Jubbulpore district ; Mandla and Bilaspur districts of the C P ; Surguja and Jaspur

States; the Ranchi district, Radhanagari in the Kolhapur States; Thana district, Bombay, and Chakar in Jammu, Kashmir State

Two or three suitable centres for the manufacture of aluminium could be set up near power sources and ore deposits There is no doubt that if the Damodar Valley project with the development of cheap and plentiful electrical energy on the lines of the T V A goes through, it will be most helpful in the manufacture of aluminium from the bauxites of Chotanagpur Cryolite will, however, have to be imported from Greenland In certain quarters it has been suggested that synthetic cryolite should be manufactured in India from indigenous fluorspar A few thousand tons of fluorspar that may be available from low grade and small occurrences near Dongargarh and in Rajputana will not be enough to meet the demand for cryolite

Magnesium —Large reserves of raw materials for the manufacture of magnesium metal by electrolytic methods or by the Pidgeon process exist in India

Mineral Development - Some Practical Suggestions

Two factors have to be considered in formulating an all-India scheme for mineral development

(*a*) Mineral deposits which could be first developed to the best advantage of India

(*b*) Regional location of the industries with a view to save on railway freights

It is obvious that the manufacture of iron and steel and aluminium, at suitably located centres, would claim priority in a development plan Side by side, some of the lesser metallic ore deposits like those of copper and gold could be worked and kept going at a fixed rate India can be divided into the following major mineral areas in the descending order of their importance —

I. *The Bihar and Orissa Circle,* with its centre at Tatanagar and a radius of 200 miles therefrom

The chief economic minerals occurring in this region are

Iron ore—Singhbhum-Orissa iron ore belt

Manganese ore—Singhbhum, Bonai and Keonjhar States

Coal—Good quality coals (including coking and metallurgical)—Jheria, Raniganj, Giridih, Bokaro, Karanpura

Flux—Limestone and dolomite—Gangpur State and Shahabad district.

Refractory materials.—High quality quartzites and vein quartz are of widespread occurrence,

Bauxite—Lohardaga, Ranchi Dist.

Dunite and Soapstone—Singhbhum Dist.

Asbestos—Seraikela State

Fireclays—Raniganj and Belpahar (Sambalpur Dist)

Kyanite—Mayurbhanj State, Manbhum Dist., and Rajkharswan (Lepso Buru)

Chromite—Singhbhum (Jojohatu) and Keonjhar State (Nausahi)

Copper—Singhbhum Dist

Apatite—Singhbhum Dist

Beryl—Hazaribagh, Monghyr and Gaya Dist

Uranium—Pitchblende in Gaya Dist

II *The Central Circle,* with Nagpur as centre and with a radius of 200 miles therefrom The minerals occurring in this region are

Iron ore—Dhulee, Rajhara, Drug District; Lohara, Chanda district; Bailadila and other deposits, Bastar State.

Manganese ore—The Nagpur-Chhindwara-Bhandara-Balaghat area, Jubbulpore Dist

Coal—Good steam coal mostly non-caking but some low ash coals partially caking may prove capable of blending with well known coking coals of Bihar It is understood that the industrial development plan of the C P Government is already providing for cheap thermal electrical energy for this region In that case requirements of distant coking coal for smelting operations in the area could be reduced

Flux—Good quality limestone occurrences have been reported from Baraduar and Akaltara in the Bilaspur Dist, Kandara in Chanda Dist, Katni, Jubbulpore Dist.; Sutna in Rewa State Fluorspar occurs near Dongargarh in the Khairagarh State. All the deposits will have to be assessed to ascertain the quantities of stone available

Refractories—It is expected that large quantities of refractory clays would be available from the coalfields of C.P Sillimanite has been reported from Bhandara Dist., Bastar State and Rewa State

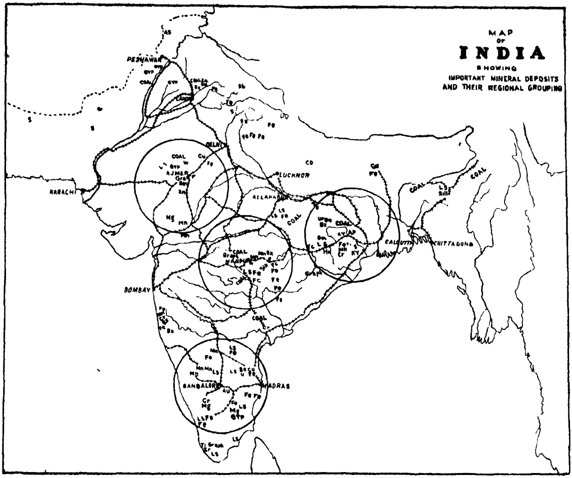
Bauxite—Katni, Balaghat (Baihar Thahsil) and Mandla

Tungsten—Nagpur Dist.

III *The South India Circle,* with its centre at Bangalore and with a radius of 200 miles therefrom The minerals occurring in this region are:

Iron ore—Haematite ore—Bababudan hills, Mysore; and Sandur State

Magnetite—Salem and other magnetite deposits in Madras Presidency,



Manganese ore—Madras, Mysore and Sandur States.

Coal—Nearest coal (non-caking) available would be from the Singarani collieries Fuel requirements may be cut down by the use of cheap electrical power, charcoal and/or inferior fuel being used for reduction of the ores South India has already developed cheap hydro-electrical energy which may be further augmented in the near future Two or three suitable centres like Bhadravati, Sandur and Salem may be fixed for the electric smelting of the local iron ores.

Flux—Limestone has been reported from Coimbatore, Cuddappah, Salem, Kurnool, Ramnad and Tinnevelly in the Madras Presidency. Good limestone is also available in the Mysore State. Data as regards quality and available quantities are lacking.

Refractories—Refractory clays have been found in the Madras Presidency and Mysore State Large high and low grade magnesite deposits occur in Mysore and Salem Sufficient chromite is also to be found in the Mysore State

Beryllium, Uranium —Nellore Dist , Madras Presidency

Celestite (Strontium) and Baryte—Madras Presidency

Gold—Mysore and Madras Presidency

IV *The Rajputana Circle*, with its centre midway between Udaipur and Ajmer and with a radius of 200 miles This region though not very rich in iron ores has considerable deposits of :—

Fuel—Lignite at Palana, Bikaner State.

Flux—Limestones of Jodhpur, Ajmer-Merwara, Alwar and Jaisalmer.

Manganese ore—mostly second grade with some high and chemical grades in the Baswara-Kushalgarh States in Southern Rajputana.

Tungsten—A small occurrence at Degana in Jodhpur State has been worked during war times

Iron ore—Limonite and magnetite are found in the Alwar and Jaipur States, but reserves are not known.

Copper—It is understood that the deposit of copper at Khetri in the Jaipur State is under investigation

Zinc—The deposit at Zavar in Udaipur State has been recently investigated but the results are not out.

Uranium, Beryllium —They are found associated with the mica pegmatites of Ajmer-Merwara at Tehari and Besundni These have been worked in war time

Bentonite—Jodhpur State

Important mineral deposits outside the areas described above are the high sulphur tertiary coals of Assam (coking and non-coking) and of the Punjab and Kashmir, high grade limestone deposits of the Khasi and Jaintia hills, sillimanite deposits of Assam (Khasi plateau), the chrome ore deposits of Baluchistan and Ratnagiri (Bombay), the petroleum deposits of Assam and the Punjab, the gypsum deposits chiefly of the Salt Range, Kashmir, Kathiawar, Sind and Trichinopoly; the monazite-ilmenite sands of Travancore and Cochin, the copper deposits of Darjeeling, Sikkim and Kashmir; the zinc deposit in the Riasi district, Kashmir State, the bentonite deposits of iron ores along the sub-Himalayan region—Kashmir State, Kumaon, Garhwal, Nainital, Darjeeling, etc, the stibnite deposits of Lahaul (Punjab) and orpiment deposits of Chitral.

The above is a brief resumé of the mineral position of India with remarks on the possible development of certain important mineral deposits for the metallurgical industries, particularly the iron and steel industry Utilization of low grade ores which are not economically workable today will depend on planned development—distributing the number of centres of smelting and giving the mineral industries the necessary measure of protection A policy of concessional railway freights is definitely called for. With the setting up and growth of the major metallurgical industries, there is no doubt that an ever increasing number of minerals and mineral products will be in demand in the country itself With a steady internal demand, an export trade in respect of the surplus manufactured or semi-manufactured products and materials could be built up India would thus get better value for her minerals and at the same time the world at large will also have access to some of her most desirable materials

MEDICINE AND PUBLIC HEALTH

PROTEIN, FAT AND MINERAL METABOLISM OF INDIANS

A REVIEW of the work carried out in the Bio-chemical Laboratory, Dacca University by Dr K P Basu and his collaborators since 1937, under the auspices of the Indian Research Fund Association, on the problem of metabolic studies on human experimental subjects are now published in the form of a *Special Report I R F A, No. 15*, June, 1946

The daily human requirements of proteins and minerals have been determined by metabolic experiments on human beings in Europe and America but it was not known whether the same standards were applicable to the people of India as well Hence this investigation was taken up to study the intake and excretion of proteins, fats and different minerals by normal adults In the opinion of the authors, a knowledge of the metabolic processes in the normal individual is necessary before deviations from the normal and pathological changes can be evaluated The minimum daily requirements of the various dietary constituents have been determined and the adequacy of the typical Indian dietaries with regard to these factors has been investigated by actual metabolic experiments The effect of some cheap and easily available supplements in making good deficiency of calcium, the mutual influence of minerals in metabolism and the role of vitamins in the metabolism of calcium, magnesium, phosphorus, iron, copper and manganese are determined

The results obtained by the experiments are tabulated in 36 tables The data on the availability of calcium in the leaves of *Cucurbita pepo*, calcium ingested in the process of betel-leaf chewing with lime etc, indicate that these are cheap substitutes for milk calcium Other vegetables, *e.g*, *Hibiscus esculentus, Brassica oleracea capitata, Moringa oleifera, Amaranthus gangeticus* are also good sources of calcium Other interesting data are the mean digestibility of different fats and oils (*e g*, mustard oil 94·1 per cent, coconut oil 99·3 per cent and Dalda vanaspati 89 8 per cent). The rate of absorption of percentage of the common fats and oils used in India are also experimentally determined on rats Similarly experiments on growth promoting effect of different fats and oils show that cow-butter fat induce maximum growth and sesame oil the least.

This bulletin on researches on human nutrition is a welcome addition to the series of special reports published by I R. F. A.

POISONOUS FOODGRAIN: WHEAT MIXED WITH LOLIUM

GREVAL and Bhaduri (*Ind Med Gaz. LXXXI*, No 8, August, 1946, p 294) have drawn attention to the possible danger of wheat being mixed with seeds of *Lolium Temulentum* (a weed), in the wheats that are being imported from various parts of the world to meet the present food shortage in India

The harmful nature of the grains of *L temulentum* (also known as 'darnel' or 'bearded wheat' in English and as *Miscara* in Arabia) has been known for centuries The seeds possess very intoxicating quality and bring on convulsions if taken in large quantities In fact, an epidemic broken out in Aden, in 1942 and continued for more than a year, where wheat mixed with 'darnel' was brought from Abyssinia and milled locally by machinery The weed is distributed throughout Europe and Northern Asia In India it occurs in the Upper Gangetic Plain From the nature of the distribution it appears that the Abyssinian wheat was imported from abroad

Usually the weed is removed before the wheat is ready for reaping or the wheat mixed with 'darnel' is sieved and the seed removed before milling or the housewife hand-winnows the wheat before milling. Obviously these precautions were not taken for the Abyssinian wheat and the weed seeds were found mixed up to 10 per cent. The poisonous nature of *L Temulentum* is due to harbouring an endophytic fungus between the seed coat and the endosperm The fungus lives symbiotically in the grains and is carried from one generation to the next through the germinating seedling to the mature grains Chemically the poison is believed to be a pyridine base called temuline

The grains of wheat and lolium differ markedly at least in size; there is also a sharp microscopical difference between the starch grains present in the endosperm of each seed.

In view of the fact that wheat is now being imported to India from various places (other than Australia or Canada) there exists the possibility of wheat-lolium admixture. We draw the attention of the Food Department, Government of India to this timely warning and the imported wheats should pass the appropriate test before being put to the market as a 'rationed' food.

REQUIREMENTS OF THE NORMAL DIET OF BENGALEES OF DIFFERENT AGE AND SEX GROUPS.

N M BASU

PRESIDENCY COLLEGE, CALCUTTA

THERE are indications in all quarters that India will attain some sort of freedom in the near future Of all the problems that would confront the administrators in the free India, the nutrition of teeming millions of India is the most pressing and complicated The nutritionist administrators of India are planning for the manufacture or import of tons and tons of various vitamins and minerals While these are necessary for the building up of an ideal health, the common man should know how to work out his own diet and requirements and how best he can provide for them from the available foods in the market, for this would be more economical for his purse It is for this reason that the author has tried in this paper to present before the ordinary person, having an elementary knowledge of mathematics and science, the scietnific method of approach to this problem In the paper the caloric needs and the requirements of proteins, fats and carbohydrates are discussed in detail but not of vitamins and minerals The diet suggested is expected to furnish in requisite amounts the ordinary needs of minerals and vitamins Extra requirements of vitamins and of some minerals, such as Ca and Fe, under certain conditions, may be met by an intake of vitamin concentrates or synthetic vitamins and some salts or by the consumption of adquately increased amounts of certain foods, such as milk, butter, eggs, etc

The normal diet of a person should be adequate with regard to the following factors —(a) the total caloric requirement of the body, (b) the proportion of the different foodstuffs, viz, carbohydrates, fats and proteins, from which the caloric needs of the body are satisfied, (c) the amino-acid make-up of the food proteins, by which the biological value or the nutritive value of the protein of one food is distinguished from that of the other, (d) the mineral constituents, particularly Ca, P, Fe, Na and Cl; (e) the various vitamins

The factors of digestibility, palatability, roughage and loss of the consumed food in the body through various ways and the unavoidable waste during cooking are to be taken into account in planning a diet

(a) *The total caloric requirement.*—The necessity for the determination of the total caloric requirement of the body is due to the fact that the most conspicuous nutritive requirement of the body is that of energy required for the support of the work of its different parts with regard to the discharge of their various functions Experiments have shown that the body can use any one of the three foodstuffs for the support of any one kind of work and has very great power to convert one of them into, or use it in place of, another and so to utilize its resources that the total potential energy of all of these three foodstuffs is economically employed to support the work of all its parts It has been also shown that under ordinary conditions each of these three foodstuffs, *viz*, carbohydrates, fats and proteins, supplies the body with the kinds of energy needed for its maintenance and for its work, approximately in proportion to their physiological fuel values of 4C, 9C and 4C* respectively per g

The total caloric requirement of a person is deduced from his surface area which can be calculated from the following formula by taking logarithms —

$$A = W^{0\cdot425} \times H^{0\cdot725} \times 71\ 84 \text{ (a constant)}$$

Where A, surface area in sq meter, W, weight in kg, H, height in cm

If the height of an average adult Bengalee male be taken to be 5 ft 5 in (*i e*, 164 cm) and his weight to be 1 md 20 srs (*i e.*, 56 kg nearly) then his surface area would be nearly equal to 1 6 sq metre The average basal metabolism† or the caloric output under basal conditions is 40C per hour per square metre in European and American countries. In India the average basal metabolism may be taken to be 10 per cent lower Therefore it comes down to 36C per hour per sq. metre, or 56×1 6C *i e.* 57·6C per hour

The total caloric requirement depends on how a person spends his day

An average adult person may be assumed to spend his days as follows:—

(*i*) 8 hours' sleep;
(*ii*) 7 hours' small activities,
(*iii*) 1 hour's walk at rates which differ according to the age and health of the person;
(*iv*) 8 hours' occupational activities, which may be either sedentary work, as that of clerks, typists, or brain workers, or light

* C—is large calorie and is equivalent to the quantity of heat required to raise the temperature of a kilogram of water from 15°C to 16°C

† The basal metabolism of a person represents his caloric output in the post-absorptive state (i e., 12 to 14 hrs. after the last light meal) during complete mental and physical rest, while awake, in a comfortably warm environment.

work as that of professional or business men, or moderate work, as that of mechanics, or heavy work as that of labourers or athletes, etc

(i) During sleep the caloric output is 90 per cent of that under basal conditions

∴ Caloric output during 8 hours' sleep—$\frac{90}{100}$ of $57.6 \times 8 = 415$C nearly.

(ii) During small activities for 7 hours, an allowance of 30 per cent over basal metabolism is generally allowed

∴ Caloric output during these 7 hours—7×57.6 (basal metabolism)

$$+ \tfrac{30}{100} \text{ of } 7 \times 57.6$$
$$= 524\text{C nearly}$$

(iii) 1 hour's walk may be at varying rates It is found that the rate of 2½, 3¾ and 5¼ miles per hour involves an extra output of 140, 240 and 580C

It is not unusual to have a rate of 3¾ miles in an hour with a majority of people below 50 years of age.

∴ The caloric output during this 1 hour of walking

$$= 57.6 \text{ (basal)} + 240$$
$$= 297.6 \text{ or } 298\text{C nearly}$$

(iv) The caloric output during 8 hours' occupational activities may be, in addition to basal output, 300 to 400 C for sedentary work, 400 to 700 C for light work, 700 to 1100 C for moderate work, 1100 or over for heavy work according to its nature

∴ The caloric output during these 8 hours' occupational work

$= 8 \times 57.6$ (basal) C + 300 to 400 C for sedentary workers or + 400 to 700 C for light workers.

$= 460.8 + 300$ to 400 or $460.8 + 400$ to 700

$= 761$ to 861 or 861 to 1161 nearly

∴ The total caloric output of a sedentary worker

$= 415$ C $+ 524$C $+ 298$ C $+ 810$ (mean) C

$= 2047$ C i e., 2050 C nearly, and the total caloric output of a light worker

$$= 415 + 524 + 298 + 1010 \text{ (mean)}$$
$$= 2337 \text{ i.e. } 2340 \text{ C nearly}$$

When a person takes food of which the caloric value is the same as his total caloric output per day, his caloric requirement is not satisfied for these two reasons:—

(1) A part of the food taken remains undigested or unabsorbed and is, therefore, excreted as faeces.

(2) The utilisation of the absorbed food involves loss of a certain amount of heat from the body; this is expressed as specific dynamic action of foodstuffs

It is customary to deduct 10 per cent from the theoretical caloric value of the mixed diet to allow for these losses* Thus the caloric value of the food to make up the daily caloric output of 2050 or 2340 should be $\frac{100}{90} \times 2050$ or $\frac{100}{90} \times 2340$, i e, 2278 or 2600 i e, 2300 or 2600 C nearly If we take the mean of these two figures, then the caloric value of each day's food should be 2450 or 2500 nearly for an average person of ordinary habits of life.

(b) *Proportion of different food stuffs to satisfy caloric needs*—The caloric requirement of 2500 is to be obtained from the 3 classes of caloric-producing foods, *viz*, carbohydrates, fats and proteins Proteins† being the most important of these three classes, their optimum amount should be provided There are two ways of determining this amount—(i) provision of 1 g. of protein per kg of body-weight, or (ii) about 10 per cent of the total caloric requirement (according to some 10 to 15 per cent) is to be obtained from the proteins of the food The average weight of an adult Bengalee has been taken to be 56 kg. Consequently his protein requirement per day would be 56 g If the protein requirement is calculated from his caloric intake, then it comes to $\frac{10}{100}$ of $2500 \div 4$‡ i.e, 62.5 gm. nearly. The mean of the two figures is 60 g nearly As the essential-amino-acid-make-up of vegetable proteins is generally less adequate and poorer than that of animal proteins, it is necessary that at least ⅓rd of the proteins consumed should be of animal origin.

Now 60 gm protein would supply 60×4 i e, 240C The total caloric requirement being 2500, the rest i e., 2260 is to be obtained from fats and carbohydrates The amount of carbohydrate in the diet cannot be reduced below a certain amount as otherwise ketosis will result and will lead to coma (unconsciousness) and finally death The formation of ketone bodies (i e, ketosis) takes place in our system mainly from fats and to some extent from proteins It is inhibited by carbohydrates in our diet, provided they are burnt in the body In the normal body carbohydrates are easily burnt, i e oxidized, but in a diabetic there is deficiency of its oxidation In the diet of a diabetic the carbohydrate content has got to be reduced to the extent to which it can be burnt and fat to be increased, but it is found from clinical

* The undigested and unabsorbed portions of the food depend on the nature of the food and also on the condition of the body The percentage of loss may be, therefore, much higher than 10%

† Proteins and some fat-like substances enter into the frame work of body-tissues which undergo wear and tear in the course of the maintenance of the activities of life Fat-like substances can be manufactured in the body from substances other than themselves, but proteins of the body can be formed either from proteins of food or their digest or hydrolysates. Hence the question of supply of protein minimum or preferably an optimum amount of protein arises.

‡ In a mixed diet the caloric values of 1 g. of protein, 1 g. of carbohydrate and 1 g. of fat are usually taken to be 4 C, 4 C, and 9 C respectively.

practice that it is not safe that fat should exceed the value of 2 × carbohydrate + ½ of protein of the diet; on the other hand it is always preferable that fat should be sufficiently less than this value. In the diet also of a normal person carbohydrate can be reduced and fat increased at most according to this formula but always preferably less than what the formula would provide. This becomes of considerable importance when the storage of carbohydrate foods (*viz.*, cereals) runs short in a country. Remembering that 2260 C is to be obtained from fats and carbohydrates, it is possible to find out the amounts of fat and carbohydrate in our diet, which will satisfy the above formula. They can be obtained from the following two equations:—

(*i*) $X = 2Y + \frac{1}{2}$ of protein $= 2Y + \frac{1}{2}$ of 60g (the amount of protein required in our diet)

(*ii*) $X \times 9 + Y \times 4 = 2260$,

where X represents the fat content, and Y the carbohydrate content of the diet.

On solving these equations we find that $X = 211$ nearly and $Y = 90$ nearly. It has been already mentioned that the value of X should preferably be less than what is obtained according to the above formula. Further, there is evidence that the *maximal complete utilization* of fat amounts to 2.5 g per kg of body-weight per day. Accordingly, *the fat content* of the diet *should not exceed* 2.5 × 56 *i.e.*, 140 *per day*, giving rise to 140 × 9 *i.e.*, 1260C. The balance of 2260 C *i.e.*, 2260 − 1260, = 1000 C is to be obtained from carbohydrate. Therefore, the amount of carbohydrate in our diet may be reduced to $\frac{1000}{4}$ *i.e.*, 250 g. But an excessive amount of fat in the diet may affect liver or cause the incidence of arterio-sclerosis, besides causing discomfort in tropical climate. Thus the fat content of the adult diet should be less than what is maximally utilizable. It is advisable to have one-fourth of the total caloric requirement supplied in the form of fat, although much smaller quantity of fat is compatible with good health at least for sometime, provided vitamins A and D are supplied and the energy needs of the body are obtained from other foods. A part of the fat of our food should be of animal origin (the more the better), for vegetable fats (oils) do not contain vitamins A and D. Hydrogenated fats and margarine, if adequately vitaminized, can replace animal fats and butter completely, provided hydrogenated fats are consumed not long after they are manufactured.*

* Mr B. N. Banerjee of Bangalore who made an elaborate series investigations about the nutrition values of hydrogenated fats, privately told the author that if hydrogenated fats after hydrogenation be kept for more than 3 months or so, they become toxic to liver and kidney. He explained this as being due to the gradual liberation of certain substances by the action of nickel dust, present in hydrogenated fats, on the fats themselves.

These considerations lead to the conclusion that the normal diet of an adult Bengalee, having an average weight of 56 kg (60 seers) should consist of *60 g protein* supplying 240C (one third of the protein taken, *i.e.*, 20 g, should be of animal origin), 69 g *fat* supplying 621 C ($\frac{2500}{4} \div 9 = \frac{625}{9} = 69.4$ g *i.e.*, 69 g nearly), a part of this fat to be of animal origin or hydrogenated, vitaminized vegetable fat; and *410g carbohydrate* $(2500 - 240 - 621) \div 4 = 410$) supplying the balance of required caloric, *viz.*, 1640C.

(*c*) *The amino-acid make up, and* (*d*) *the mineral constituents*.—The requirements of minerals particularly Na, K, Ca, P, Fe and Cl and of vitamins are satisfied, if the food includes sufficient amounts of milk, leafy and other vegetables and fruits, but in the case of infants and expectant and lactating mothers additional vitamins A & D should be supplied in the form of a liver oil.

The palatability and digestibility depend to a great extent upon cooking and selection of foods and the roughage is supplied by the leafy vegetables and the bran present in extraction flour. Without a certain amount of roughage supplied by celluloses and hemi-celluloses present in leafy vegetables, the "daily scrubbing" of the alimentary canal and proper defaecation do not take place.

The various articles of food for human consumption from which the different essential components of the diet are to be obtained may be divided into the following groups: (1) milk and dairy products, (2) potatoes and sweet potatoes, (3) beans, peas, pulses and nuts, (4) tomatoes and citrus fruits, (5) leafy, green and yellow vegetables, (6) other vegetables and fruits, (7) eggs, (8) meat, poultry and fish, (9) flours cereals and millets, (10) butter, (11) other fats and (12) sugars and jaggery.

Milk. The importance of milk in our dietary would be evident from the following considerations:—

(*a*) It has been realised that the enrichment of our dietary with vitamins A and C, riboflavin and Ca is not only beneficial and protective against actual deficiency but promotes and enhances vitality or positive or buoyant health. Milk furnishes all these factors and is an outstanding source of three of them, *viz.*, Ca, vit. A and riboflavin. Fruits and leafy vegetables supply generally two of these factors.

(*b*) According to Mitchell and Hamilton milk, fruits and vegetables, lactose and dextrin tend to result in a superior intestinal hygiene and that the value of milk is not due simply to its lactose but also to casein which is better than meat or egg protein or even vegetable protein in promoting the development of a wholesome bacterial flora in the alimentary tract.

(*c*) It has been shown by Sherman that experi-

mental rats* can thrive well for many generations on a diet, 1/6th of which is whole milk and the remaining 5/6th is ground whole wheat If the proportion of milk be increased from 1/6th to 1/3rd and the ground whole wheat reduced from 5/6th to 2/3rd, growth of animals is more rapid and more efficient, death-rates are lower, vitality is higher at all ages, well-marked increase in the average length of adult life takes place and the period of the prime of life is extended in greater ratio than the life-cycle itself

(*d*) On experimenting with diets in which, the protein was furnished, (1) almost entirely by meat, (2) almost entirely by milk, (3) almost entirely by a mixture of bread and milk in such proportions that the protein came in practically equal amounts from these two foods, Rose *et al* found that Nitrogen was stored in these 3 cases as follows (1) 0·06 g per day, (2) 0·55 g and (3) 0·41 g The food in each case furnished 0·08 g N_2 per kg of body-weight per day These experiments show that proteins of milk and of bread-milk mixture are more efficient than those of meat.

Amongst the dairy products curd is almost as nutritive as milk Skim milk is also a valuable food, but is, of course, devoid of fat and vitamins A and D, soluble in fats Whey water contains Ca and riboflavin (vitamin B_2) of milk and two of its proteins, *viz*, fact-albumin and lact-globulin, lact-albumin being of much higher biological value than casein, the principal milk-protein It should not, therefore, be wasted *Butter-milk* is prepared either from defatted (by hand churning) soured whole milk by dilution or from washings of cream during the manufacture of butter in dairies The former is of high nutritive value, but the latter is of much lower value, yet it should not be wasted

Potatoes and sweet-potatoes—They are carbohydrate-rich foods, potatoes containing nearly 20 per cent carbohydrate and 2 per cent protein, and sweet-potatoes containing nearly 30 per cent carbohydrate and 1·8 to 1·6 per cent protein Sweet-potatoes being fibrous, if taken in large excess, may irritate the alimentary canal and lead to diarrhoea Weight per weight the caloric value of sweet-potato is greater than that of potato.

Beans, peas, pulses and nuts.—Beans, peas and pulses contain nearly 20 to 25 per cent protein of low biological value and nearly 60 per cent carbohydrates Soya bean is an exception and contains nearly 43 per cent protein, 20 per cent fat and 20 per cent carbohydrate.

Nuts. Nuts are richer in proteins of low biological value and fats Cashew nuts and ground nuts are cheap and may be taken Cashew nuts contain 21 per cent protein, 47 per cent fat and 22 per cent carbohydrate and ground nuts contain 27 per cent protein, 40 per cent fat and 20 per cent carbohydrate These nuts should never be taken in excess Half to 7 oz. daily would be a good supplement to poor rice-eater's diet

Tomatoes and Citrus fruits—Tomatoes are rich in carotene and vit C and oxalates and citrus fruits are rich in Vit C Citrus fruits may be taken in abundance without any positive harm, but tomatoes in excess may produce oxaluria

Green and Yellow leafy Vegetables—They supply the important minerals, carotene and vit C and constitute the roughage in food, of which the importance has been already stressed Further, they tend to improve the intestinal hygiene They generally contain protein in not insignificant amounts

Fruits and other vegetables—Fruits supply vit C generally, improve the intestinal hygiene and help in defaecation

Other vegetables supply the various minerals Their protein content is, as a rule much lower than that of leafy vegetables

Eggs—They are rich in protein of high biological value, fats and phospholipides, sterols, vit A and D, riboflavin and Fe They are, therefore, very good for growing children, but they do not, like milk, fruits and vegetables, have the property of reducing intestinal putrefaction and promoting the development of a wholesome bacterial flora in the intestine On account of this defect and of their high content of sterols, eggs should be taken with caution in old age

Meat, poultry and fish—They supply protein of high biological value Their protein content varies between 18·5 per cent and 22·5 per cent Lean meat, small fish and poultry are more easily digestible than fatty meat, or big fish

Flours, cereals and millets—These are rich in carbohydrates Amongst the cereals, rice is widely taken in Bengal Home-pounded, parboiled rice is the best and raw, milled rice is the worst amongst the various kinds of rice available in the market The former is richest in protein, vit. B_1 and minerals, and the latter poorest in protein, vitamin B_1 and minerals. Millets are not customarily taken in Bengal by Bengalees. Amongst the millets bajra, juar and maize are more or less similar to wheat flour, but poorer in nutritive value and less digestible

Wheatmeal or 85 per cent extraction flour is now-a-days used in England and U S A in preference to 70 per cent extraction white flour, as the former contains more thiamin, riboflavin, and nicotinic acid and a larger amount of roughage. But as it contains more

* Rats are selected for experiments on nutrition because they are omnivorous like humans and the chemistry of their nutrition is closely analogous to that of the latter

phytic acid than white flour, Ca is precipitated as an insoluble compound It is, therefore, fortified with $CaCO_3$ in the ratio of 7 oz of $CaCO_3$ to 280 lbs of flour (i e, 60 mg Ca per 100 g flour) The digestibility and caloric value of wheatmeal are lower than that of white flour Wholewheat flour would no doubt contain more of Vit. B complex, but it is still less digestible, has still less caloric value and renders a greater amount of Ca unavailable It would, therefore, be not prudent to use it unless fortified by $CaCO_3$ Moreover, it might irritate the alimentary canal of those who are not used to it

Butter and other fats —A certain amount of fat is essential, for the warm-blooded animals cannot manufacture in appreciable amounts some unsaturated fatty acids, *viz*, linoleic acid, linolenic acid etc., which are probably essential for nutrition. Further, animal fats (not lard) are sources of vitamins A and D to the body, but vegetable oils are not (excepting vitamin E). Unless, therefore, vegetable oils are vitaminized (i e, vitaminized hydrogenated fats), a certain amount of animal fats must be present in our food

Sugars and Jaggery —Jaggery is preferable to sugar, for it contains several minerals, particularly Fe in large amounts

(To be continued)

BOOK REVIEWS

The Life of Oscar Wilde—By Hesketh Pearson Illustrated Pp 398 *Methuen* Price 16s

MR HESKETH PEARSON maintains his reputation as a biographer by his life of Oscar Wilde He gives us a very understandable background of Wilde's early life which explains much not only of his early achievements but of his later unfortunate aberrations also The story of his career from his school and college days through the brilliant *salons* of the nineties which he lit up with his flashing wit to his tragic end in poverty and disgrace is remarkably well told Everywhere he evokes sympathy and often the warmest appreciation of Wilde's genius, and this without extenuating anything of that which once had appeared to be so abominably sordid The whole story is enlivened by a most ample citation of those *bon mots* in which indeed Wilde had no parallel, and many of which surely deserved to be rescued from oblivion Mr Pearson mentions Wilde's early fondness for the Disraelian novels and sketches, but without the obvious suggestion of the very marked way in which he modelled his own epigrams on those of the Victorian master. Equally with these *mots* we will value the ex-tem-pore parables with which Wilde often illustrated his point, and which prove that fundamental wisdom needs no peculiar holiness. The reference to Wilde's review of *Primavera* reminds us that one of the four collaborators was Manmohon Ghose and his best praise was reserved for him. The treatment of the various episodes in Wilde's life is refreshingly objective and documented, and nowhere more so than in that of the last painful episode Perhaps one might feel inclined to wish that it had been more concisely done, since whatever interest the affair might have for a student of abnormal phychology it can have none for the student of literature as it had not the least influence on Wilde's artistic life

The central fact about Oscar Wilde was that he never grew up He had all the virtues of a petted and some of the vices of the spoilt child The prudish Victorian however would accept him only as a grown-up man, and hence the unsparing harshness of that judgment which destroyed the artist without redeeming the man

Except for some typographical faults which catch the eye because usually so rare in British book-making, the printing and the general get-up are excellent

D G.

International Relations in Science—By Walter B. Cannon and Richard M. Field *Chronica Botanica*, Vol 9, No 4, Autumn, 1945. Pp 251-298, the Chronica Botanica Co., Waltham, Mass, U.S A.; Macmillan & Co, Ltd., Calcutta

THIS is a booklet prepared on behalf of the Division of Foreign Relations of the U. S. National Research Council, reviewing the aims and methods of International Relation in Science, both in the past and in the future.

At a meeting of the executive committee of the Division of Foreign Relations held in 1943, there was some discussion of the war-time activities of the International Scientific Unions and a questionnaire was issued in March, 1944 to all International Scientific Unions and Congresses The bulk of this brochure is devoted to a digest of the replies to the questionnaire, and the authors sub-divides the sciences and the scientists as under A *The extra-terrestrial sciences*—such as Astronomy and Cosmogony, B. *The terrestrial or geosciences*—such as Biology, Geography, Ceology, Geophysics and C *The primary Sciences*—such as, Mathematics, Chemistry and Physics Under each of the subdivisions are outlined the numerous existing and proposed international unions, their aim and scope of work and the subjects dealt with are Astronomy, Biology, Horticulture, Paleontology, Paleobotany, Vertebrate paleontology, Medicine, Psychology, Archaeology, Geography, Geology, Economic Geologists society, Association of Petroleum Geologists, Geodesy and Geophysics, Seismology, Meteorology, Magnetism and Electricity, Oceanography, Volcanology, Hydrology, Commission on Snow and Glaciers, Subterranean Waters, Continental and Oceanic Structure, Pure and Applied Physics, Chemistry and Mathematics The digest further includes a report of the activities of the International Science Congress of 1944, International Scientific Organizations, International Directories and an excerpt from the International Conference on Intellectual Co-operation in Havana, 1941

The majority opinion of the international scientific organizations is that they are an essential implement to the progress and comity of nations, and that the most effective organized method of international co-operation in science is by means of the international scientific unions

The brochure concludes with appendices of a list of those who have contributed to the preparation of this booklet and Joseph Needham's memorandum on "The Place of Science and International Scientific Co-operation in Post-War World Organization"

Copies of the booklet may be obtained, without charge, from the Division of Foreign Relations of the National Research Council, 2101, Constitution Avenue, Washington, D C, or from the Chronica Botanica Co, Waltham 54, Mass

The publication will be continued on an annual basis entitled "Annual Report of International Relations and co-operation in Science and Technology" in the *Chronica Botanica* and will be made available as a special reprint.

A. K. G.

Ānabik Bomā (Atomic Bomb)—By Samarendra Nath Sen Illustrated Published by Brindaban Dhar & Sons Ltd, 5, College Square, Calcutta Price Rs 3/- net

Atomic energy today is a subject of international politics The world at present appears to be sharply divided between two groups of nations—one possessing the secrets of utilizing atomic energy and trying to take advantage of it in power politics, the other lacking intelligence of this secret and making a desperate bid to attain it through smuggling as well as through their own scientific and technical abilities To reconcile these two groups, the Atomic Energy Commission of the UNO has been recently set up Whatever may be the final international agreement on this scientific discovery, the atomic energy, or better the menace of it, is destined to play an important role in post-war peace and politics for some time to come The only hope for averting the catastrophe of an atomic warfare and for building an enduring peace through peaceful use of atomic energy must ultimately lie with an enlightened world public Easy and abundant access to accurate, factual, yet popular, description of the methods of science will be a powerful factor in dispelling ignorance and building up enlightened opinion

It is for these reasons that the general readers will welcome the publication of the present book (in Bengali) under review The writer of this book has already made his mark as a prolific writer in science, both in English and in Bengali and has done well to write one at a time when factual information on development in atomic energy is most needed

The book is prefaced by Prof M N Saha and divided in eight chapters The opening chapter records the international reaction of the explosion of atomic bomb upon the Japanese cities of Hiroshima and Nagasaki The subsequent two chapters attempt to familiarize the readers with current conception of atoms, molecules, electrons, atomic structure, the properties of radio-active elements, spontaneous and artificial radioactivity, neutrons, isotopes, and nuclear structure of matter In the fourth chapter, the author discusses the fission of uranium nucleus, Bohr-Wheeler theory, the discovery of neptunium and plutonium and the chain reaction This thread of the narrative of scientific discoveries is temporarily broken in the fifth chapter in which the efforts of the Governments of U S A, U K, and Canada in organizing atomic energy projects have been described This has been a pleasant diversion. In the sixth and the seventh chapter, the manufacture of the ingredients of the atomic bomb, *viz*, uranium-235 and plutonium, some particulars of the bomb, and the explosion of the first experimental bomb in the desert of New Mexico

have been described. The eighth chapter has been most fittingly devoted to a discussion of the peace-time possibilities of atomic energy. A post-script containing account of the Bikini atoll experiment and the report of the British mission which visited the atomic-bomb-devastated areas in Japan has brought the book up-to-date The book is lavishly illustrated 27 diagrammatic sketches, 26 half-tone pictures, and a well-designed cover have made the book highly attractive So far as we are aware, this is the first of its type in an Indian language and deserves a wide publicity

A. K. G.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters*]

A NOTE ON THE PREPARATION OF QUINOLINE

SKRAUP's synthesis of quinoline is often accompanied by a violent reaction and the yields therefrom are variable Some of the modifications of the Skraup's method that have been introduced from time to time are (1) "ferrous sulphate modification" of Clerk and Davis[1], (2) "acetic acid modification" of Cohen and Gustavson[2], (3) "thorium vanadium oxides method" of Darzens *et al*[3], (4) "boric acid method" by Cohen's[4], and (5) "acetanilide modification of the boric acid method" by Manske *et al*[5]

A recent British Patent[6] describes a method "*for the preparation of compounds containing fused pyridine rings, especially quinoline by condensing aniline and glycerol by means of concentrated sulphuric acid in presence of iodine or iodides*" As we required large quantities of quinoline for our work, it was thought of interest to establish the conditions for its preparation by this new process

No	Aniline	Conc H_2SO_4	Glycerine tech		Catalyst	Temperature	Time	Yield
	g	g	g		g	°C	hrs	g
1	38	100	50	Iodine	1	135-140-175	4-5	26
2	38	100	50	Iodine	1 6	135-140-175	4½	33 5
3	38	100	50	Iodine	1 6	do	4¼	32
4	114	300	150	Iodine	5 1	do	6	96
5	38	100	50	Iodine	2 5	do	4½	34
6	38	100	50	Na I	0 8	do	4½	19 5
7	38	100	50	Na I	0 8	180-190	4½	15
8	38	100	50	Na I	2 5	135-140-175	4½	30
9	38	100	50	Na I	2 5	do	4-5	29
10	38	100	50	$HgSO_4$	8 0	do	8	2
11	38	100	50	$HgSO_4$	8 0	180-185	8	—
12	38	128	150	Boric acid $FeSO_4$ Nitrobenzene	25 g. 14 g 29 5g		5	36

From a series of eleven experiments using iodine, sodium iodide or mercuric sulphate as catalyst (*vide* table), conditions for the preparation of quinoline in yields comparable with those obtained by Cohen's[4] method (*vide* experiment No. 12 in the table) have been established

The violence of the reaction is avoided by (*i*) adding sulphuric acid or glycerol in stages, (*ii*) controlling the temperature at 135-145°C in the beginning and then raising it to 175°, and (*iii*) stirring the reactants The method has the following advantages over Cohen's method, *viz* , (1) it takes less time, (2) avoids use of nitrobenzene and the consequent steam distillation, (3) requires less glycerol. Quinoline obtained by this method contains about 6 per cent of aniline and is good enough for most purposes after one distillation The traces of aniline can, however, be removed by the usual method of diazotisation A typical experiment is detailed below

Preparation of quinoline —Aniline (38 g) and glycerine (50 g) were taken in a 500 c c 3-necked round bottom flask fitted with a mercury sealed stirrer, a thermometer and condenser connected to a gas trap Concentrated sulphuric acid (50 g) was added under cooling with stirring Iodine (1·6 g.) was then added and the flask was heated to 135° slowly with rapid stirring The reaction started at 135° with a brisk evolution of SO_2, and was maintained at 135-140° After 1 hour a further quantity of conc. sulphuric acid (25 g.) was added and the temperature maintained at 140-145°. The remaining acid (25 g.) was then added after another half-an-hour and after 3 hours from the beginning of the reaction, the temperature was slowly raised to 175-180° during 1½ hours when the evolution of SO_2 practically ceased indicating the completion of the reaction The reaction mixture was cooled, diluted with water to double its volume and slowly run

under cooling into a solution of 50 per cent NaOH (300 c c.) The mass was then steam distilled and the quinoline separated from the distillate Distillate was extracted with benzene to recover residual quinoline and after distilling off benzene, was combined with the separated portion, dried over KOH and distilled, b p 225-228°, yield 33 5 g It contains traces of aniline On diazotisation, 50 grams of this crude quinoline gave 47 g of pure quinoline, b p, 231-232°

Our thanks are due to Prof P C Guha, D Sc, F N I, for his keen interest in the work

B C JAIN
B H IYER

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[1] Clerk and Davis, *Organic Synthesis*, 2, 79, 1928
[2] Cohen and Gustavson, *J Amer Chem Soc*, 50, 2709, 1928
[3] Darzens *et al*, *Bull Soc Chem*, 47, 227, 1930
[4] Cohen, *J. Amer Chem Soc*, 52, 3685, 1930
[5] Manske *et al*, *Can J Res*, 19, 318, 1941
[6] British Patent, 549502, cf *Amer Chem Abst*, 753, 1944

EFFECT OF SUPPLEMENTS ON THE BIOLOGICAL VALUE OF THE PROTEIN IN GROUNDNUT MILK

IN a previous communication[1] it has been shown that the protein in groundnut milk has a relatively lower biological value than that in soya or cow's milk that groundnut milk has practically no supplementary value when added to the South Indian diet These defects, combined with the facts that the milk curdles rather quickly on standing and that the oil in the milk turns somewhat rancid during extended boiling, tend to reduce the scope of groundnut, by itself, as a source of a good vegetable milk At the same time, groundnut has the advantage of being a cheap and well established oilseed, with abundant scope for production and easily available in practically all the provinces of the country If, by further improvement in processing and incorporation of suitable supplements, the nutritive value of groundnut milk can be enhanced, it will be of distinct advantage under the present conditions. This note deals with the improvement of the biological value of the protein by the rat growth method

Preliminary experiments had shown that groundnut kernel gives stable emulsions in combination with soya-bean, as also with small percentages of germinated barley or ragi (*Eleucine Coracana*) These were accordingly tried as supplements in different proportions, the flavour, taste and keeping quality being determined for a number of batches of each preparation At the same time the biological value of the mixed protein in each preparation was determined. The procedure was the usual one, young rats (40-50 gms. in weight) being given the standard nitrogen-free ration together with the milk preparations which were incorporated along with the diet in such a proportion as to bring the level of protein in the diet, on a dry basis, to 10 per cent. The milk formed the sole source of protein in the diet Adequate quantities of vitamins were also given as supplements Six animals were used for each series and the experiments were continued for a period of six weeks. The results have been presented in the following table —

	Source of the milk	General properties of the milk	Increase of weight (in gms) per gram of protein consumed
1	Milk from ungerminated groundnut	Good taste, but flavour reminiscent of groundnut milk—turns rancid on prolonged heating	1 50
2	Milk from germinated groundnut (germinated for 2 days)	Better taste than (1) — flavour still reminiscent of groundnut—turns rancid on heating and develops off-flavour on standing	1 75
3	Milk from a mixture of germinated groundnut (75%) and germinated soyabean (25%)	Better taste and flavour than (2) Groundnut flavour largely masked—does not turn rancid on heating or extended standing	1 85
4	Milk from a mixture of germinated groundnut (75%), germinated soyabean (15%) and malted barley (10%)	Best in the group in regard to taste and flavour —does not turn rancid on heating or standing	1 97
5	Milk from a mixture of germinated groundnut (75%) and ragi (25%)	Emulsion unstable—the ragi protein separates on strong heating or on standing	1 64
6	Milk from a mixture of groundnut (75%), soyabean (15%) and ragi (10%)	Satisfactory in regard to taste and flavour—does not turn rancid on standing	1 83
7	Milk from a mixture of groundnut (75%), soyabean (15%) and barley (10%)	Better than (6)—milk fairly stable—does not turn rancid on heating or standing	1 91

The foregoing experiments have brought to light two important features in regard to the improvement of groundnut milk. Addition of even 15 per cent of soya-bean stabilises the milk and protects the oil

from turning rancid Soya-bean is rich in Vitamin E and this may have a protective action on the oil in groundnut milk. Addition of ragi (25 per cent) also confers a similar protection, but the emulsion is not stable Combination of both soya-bean and ragi improves both the stability and the nutritive value The best result has been obtained by addition of soya-bean and malted barley * Apart from improvement of taste and flavour, the protein is also well balanced and the biological value of the mixed proteins in the milk is nearly equal to that of cow's milk From previous studies[2] in the laboratory, it has been found that the biological value of the proteins of cow's milk is 2 00 as determined by the rat growth method under similar conditions

The above would present a very promising line of future approach Groundnut is plentifully available in every part of the country and, especially in South India where milk deficiency is quite acutely felt With a small supplement of germinated soya-bean and malted barley, a fairly attractive milk, cheap and well-balanced in regard to proteins can be prepared Such a milk can be further balanced in regard to minerals and vitamins, thus making it a good supplement to the poor rice diet Further experiments in this direction are in progress

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[1] Desikachar, De and Subrahmanyan, Science and Culture, 12, 1946

[2] Desikachar, De and Subrahmanyan—to be published in *Annals of Biochemistry*, 1946

* It is interesting to note that, during the Bengal famine of 1943, Guha, Ahmad *et al* used a mixture of groundnut, soya-bean and malt for feeding destitutes In their trials the groundnut and soya-bean had been gently roasted prior to grinding The mixed product stood long transport and kept well during storage It could be utilised at short notice and provided a nourishing drink and food to persons who badly needed it

PHARMACOGNOSTIC STUDIES ON INDIAN CINCHONA

The important official drug quinine is obtained from the barks of different species of *Cinchona* which are all natives of Tropical South America The plant was introduced in India by Dr Royle and plantations were started in Darjeeling (Bengal) as well as in South India. At present among the various species of *Cinchona*, the following are given prominence in the plantation at Mungpoo in Darjeeling, *viz*, *C. ledgeriana* Moens, *C succirubra* Pav., *C. robusta* How, hybrids between *C. ledgeriana* and *C. officinalis*, and between *C. ledgeriana* and *C. succirubra*

One of the most striking characters of *Cinchona* barks is the diverse nature of its chemical composition One might surmize that quinine can be obtained from any genuine *Cinchona* bark, but in practice it is found that quinine is a minor constituent or is even absent in the bark of many true *Cinchona* species The age of the plant and the locality at which it grows are the two factors which exercise considerable influence on the percentage of alkaloid content and it is found that the cultivated and improved varieties yield up to 13 to 14 per cent of crystallizable alkaloids with more than 90 per cent as quinine whereas on the other hand many wild forms contain only traces of crystallizable alkaloids with no quinine The present study was undertaken to determine the variation in qualities of the barks due to difference in age and grown in different localities at Mungpoo

The samples of bark are usually about 30 cm. long and 0 2 to 0 7 cm thick in small curved pieces The root barks of different ages possess somewhat uniformity in structure although the number of fissures in older barks are greater than those in the younger roots The stem barks are reddish or dark brown often with greyish patches of foliaceous lichens, and the outer surface is roughened with corky ridges or protuberances and marked with transverse fissures The younger stem barks show presence of wrinkles with a few cranks but in older ones external surface presents a large number of transverse fissures together with a few longitudinal cracks In sections, the younger barks are found to possess corky tissue which in the older ones is found to be cast off The number of sclerotic cells in root bark is also greater than those in the stem bark and their number also varies in young and older barks being somewhat greater in the older samples

The chemical assays were conducted with bark powders of different samples of the various age groups. Barks from 3 to 9 years old plants of *C. ledgeriana* grown in the various localities, *viz.*, at Rungbee, Mungpoo, Labdah, Settong, Mungsong, Kashyem, Burnick and Sangseer were studied in detail Barks from other species and hybrids of different ages up to 17 years grown in these different localities were also studied.

It is found that the total alkaloid content of *C ledgeriana* barks varies from 4 to 6·5 per cent in plants of 3 to 9 years age and it goes up to 7 to 7·5 per cent in the 12th year thus indicating that *C. ledgeriana* plants will give a maximum yield of total alkaloids in the 12th year As regards percentage of

quinine, it was observed that it goes high in 6 to 9 years old plants in general. The total alkaloid content of the hybrid between *C ledgeriana* and *C succirubra* varies in general from 5 to 7 per cent and its quinine percentage is lesser than that of *C ledgeriana* In the hybrid between *C ledgeriana* and *C officinalis*, the total alkaloid content varies from 5 to 7 5 per cent and the percentage of quinine reaches maximum in the 7th year The total alkaloids of *C robusta* is about 4 5 per cent of which quinine content varies from 48 to 55 per cent thus pointing that *C robusta* and *C succirubra* are much inferior to *C ledgeriana* and the hybrids

It is further observed that among the various plantations in the Darjeeling district, those at Rungbee, Kashyem and Mungsong yielded barks richer in alkaloid content than those grown at other places, thus pointing that they are more favourable to the cultivation of *Cinchona*

These analysis show that the maximum percentage of quinine obtained from Indian barks is 4 53 as found in 10 to 12 years old trees of *C ledgeriana* The official records show that *C ledgeriana* contains quinine having a percentage variation of 4 to 13 per cent By scientific methods of arboriculture the quality of bark produce can be greatly improved and this has been effected well in Java bark[1] In 1890, the average percentage of quinine (calculated as sulphate) in Java bark was 4, in 1893 it had risen to 4 6 while in the five years from 1900 to 1904 inclusive, the average quinine percentage of all the Java barks sold in the Amsterdam market was 5 37, in 1924 it was 6 per cent and during recent years it had an average yield of 7 5 per cent quinine It is not known whether such attempts have been made at Mungpoo to improve the quality of Indian Cinchona and it is suggested that proper genetical and physiological methods must be resorted to improve the quality of Indian barks

We are indebted to Messrs Bengal Immunity Co, Ltd., Calcutta for providing us the necessary funds to carry on the work, to Mr S C Sen B A (Cant), B Sc (Cal), A M I Chem E, Principal Quinine Officer to the Government of India for his kindness in sending the samples of barks and to Messrs S Mukherjee, M S. Mukherjee and R P Banerjee of the Bengal Immunity Co, Ltd, for analyzing the different samples of the bark powders

The details of the paper will be published elsewhere.

S C DATTA
S N BAL

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Industrial Section, Indian Museum,
Calcutta, 8-8-1946.

[1] United States Dispensatory by Wood & Osol, 1943

FOOD AND ITS PERCENTAGE COMPOSITION OF THE COMMON ADULT FOOD FISHES OF BENGAL

THE nature of food for a particular class of living organisms has a relative bearing to the environmental conditions under which it lives Obviously therefore, one must know the specification of food in all its analytical standpoints, both qualitatively and quantitatively, when one goes in for a culture of a particular life

Pisciculture stands in demand of such a culture The importance of fish in the role of balanced diet is unquestionable The problem of how to increase production of fish has already drawn attention of scientists and lay men alike The main problem lies in the solution of the nature of food, its percentage composition of quality and quantity and other varied bearings related to fish-life Inspite of the great importance of the food problems very little attention has so far been given to it

The study of the food of fish began to attract the attention of scientists only towards the close of the last century As the nature of food depends to a great extent upon the nature of environment, the problem is interesting from specific as well as ecological points of view

Job (1940) in his paper "An investigation on nutrition of the perches of the Madras coast"[1] has tackled the problem of the percentage composition of the different items of food of the marine and estuarine perches of Madras Mookerjee, Ganguly and Sarkar (1946) reported "On the composition of food of Indian Mullet, *Mugil parsia* with suggestion to culture it in fresh-water ponds of Bengal"[2] Mookerjee and Ghosh (1945) reported on "Food of major carps"[3] Mookerjee (1944) has published an account on "Food of fresh-water fishes"[4] In Great Britain Hartley (1940) contributed a paper in this line entitled "The Food of Coarse Fish"[5] Mookerjee, Ganguly and Islam (1946) reported "On the composition of food and their correlation with weight-length of body in the development of *Ophicephalus puctatus*"[6] And lastly Mookerjee and Sen Gupta (1946) reported "Correlation of food, gut-length and body-weight in *Cirrhina reba*"[7]

With a view to solving this most important problem we started in our laboratory several extensive examinations on the stomach-contents of the common edible fresh-water fish of Bengal. Collections were plenty with each of the varieties and care was taken to bring in fish from different water courses and other sources so that a precisely comparative view on their standard food-affinity and deviation could well be studied. The estimations were then made in each case on treating the stomach-contents under both high and low power of the microscope The number

of each specimen with their percentage composition of food is tabulated here (Table I)

It is, therefore, convenient that stocking should be made in such a position as to avoid competition

TABLE I

SHOWING THE DIFFERENT ITEMS OF FOOD EXPRESSED AS PERCENTAGES OF DIFFERENT SPECIES

	Algae	Higher plants	Protozoa	Worms	Crustacea	Insecta	Mollusca	Fish	Scales	Mud & sands	Name of the fish
Group A	25	10	20		45						*Catla catla*
	45	20	23		15					7	*Labeo rohita*
	12	38	15		20					15	*Cirrhina mrigala*
	10	70	5		10					5	*Cirrhina reba*
	10	48	12		10		5			15	*Labeo calbasu*
	27	45	20							8	*Barbus sarana*
Group B	40	15	30			15					*Barbus stigma*
	58	16	21							5	*Colisa lalius*
	51	25	15							9	*Colisa fasciata*
Group C					33			67			*Nandus nandus*
	10	25	22	9	10	8				10	*Notopterus notopterus*
Group D	10	17	23	3	30	15				2	*Anabas testudineus*
	18	27	13		24	11				7	*Mystus vittatus*
	14	31	18		26					11	*Callichrous pabda*
Group E	50								13	37	*Mastacembelus pancalus*
	44								16	40	*Mastacembelus armatus*
	48								11	41	*Rhynchobdella aculata*
Group F	10	17	18	10	20	15				10	*Heteropneustes fossilis*
	7	13	15	15	27	11				12	*Clarias batrachus*

From the above observations it can be concluded that the percentage composition of food of the fish leads one to show that a particular group shows affinity towards particular items of food Thus, taking into account the percentage of those items of food the fishes can be grouped under several heads While stocking such groups into a tank knowledge of ecology of water is essential as the flora and fauna that are directly responsible for the upkeep of the fishes have definite affinities to particular water levels The fishes that chiefly subsist on such flora and fauna adapt a closer relationship with their zonal habitats As fish that lives in surface takes crustacea and algae whereas the fishes that take rotten plants, sand and mud suggest that they are bottom feeders

Broadly speaking, no fish is either genuinely carnivorous or herbivorous But taking into consideration the maximum percentage of the food items we may class certain groups into such types Thus *Nandus nandus* and *Notopterus notopterus* may be called carnivorous in habits while spiny eels (Mastacembelidae) may be grouped under herbivorous type

In accordance with this view we have tried to classify the fishes chiefly on the basis of their affinity towards the quality and quantity of the item of food they take (Groups A, B, C, D, E, F).

for food amongst the different species of fish Hence, it will be wise and profitable to stock adult herbivorous fishes with adult carnivorous types This will minimize the competition and at the same time food of the different zonation in the water levels will be utilized with least wastage We should note here that adolescent herbivorous and adolescent or adult carnivorous types should not be kept together for they may lead to a disastrous effect

Excepting the carps this permutation and combination system of inter-grouping can be conveniently experimented upon The carps are more or less omnivorous and each has developed a special affinity due to adaptation towards the zonal fauna and flora of the pond Hence, competition among them is less marked Group A may however be stocked with Group C. because, the latter are markedly carnivorous while the former are omnivorous In this case, if some fodder fishes can be conveniently introduced into the pond, the hard competition for carnivorous food may be avoided Besides this, groups like B & D and E & C can have a joint stocking In each case either of the two one is of carnivorous type while the other chiefly subsists on rotten vegetation and plant bodies

The special feature of the group F (*H. fossilis* and *C batrachus*) however is that they cannot be

stocked with any other group described in the table as they can only thrive in acidic water unlike others

Such grouping are not only economically helpful, but these afford us a maximum output in the minimum space.

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NOTE ON TESTS APPLIED TO SAMPLES FROM NORMAL BIVARIATE POPULATION

Let $x_{i1}, x_{i2}, \ldots, x_{in}$ $(i=1, 2)$ be a sample of size n from a normal bivariate population with the parameters m_i, σ_i^2, ρ, $(i=1, 2)$.

Put $x_i=(x_{i1}+x_{i2}+ \quad + x_{in})/n$, $s_i^2=\sum_j(x_{ij}-x_i)^2/(n-1)$

$$s_{12}=\sum_j(x_{1j}-x_1)(x_{2j}-x_2)/(n-1).$$

We will consider the testing of the following hypotheses.

I. The hypothesis $m_1=m_2=m$ (unknown)

If no knowledge is presumed about σ_1^2, σ_2^2, ρ & m, the t-test with n-1 degrees of freedom $(t=(x_1-x_2)\sqrt{n}/\sqrt{(s_1^2+s_2^2-2s_{12})})$ makes a valid test of the hypothesis and possesses all the properties of Student's 't' when comparison is made with other critical regions similar to the sample space with respect to σ_1^2, σ_2^2, ρ & m

If we further assume $\sigma_1^2=\sigma_2^2=\sigma^2$ without knowing the common σ^2, ρ and m, it is found that the above t-test cannot be improved upon from consideration of power when we want to make the test independent of σ^2, ρ & m.

In the latter case, Fisher suggests the t-test $(t=(x_1-x_2)\sqrt{n}/\sqrt{(s_1^2+s_2^2)})$ with $2n-2$ degrees of freedom for small but unknown values of ρ. It may, however, be noted that Fisher's 't' is not an exact test here, distribution of 't' involving ρ:

$$\int_{-\infty}^{t}\psi(t)dt=\left(\frac{1-\rho}{1+\rho}\right)^{\frac{n-1}{2}}\left\{\int_{0}^{t}f_{2n-2}(t)\,dt+\sum_{i=1}^{\infty}\frac{(n-1)(n+1)\quad(n-3+2i)}{i!}\left(\frac{\rho}{1+\rho}\right)^{i}\int_{-\infty}^{\frac{t\sqrt{2n-2+2i}}{\sqrt{2n-2}}}f_{2n-2+2i}(t)\,dt\right\}$$

This test controls the first kind of error in the sense that error is less than the level of significance when ρ is positive, but we cannot get the advantage of increased number of degrees of freedom in estimating σ^2 for controlling the second kind of error unless ρ is very small—for $n=5$, ρ should be less than 0·1.

If, however, in addition to the assumption $\sigma_1^2=\sigma_2^2=\sigma^2$, ρ is known, we can get the full advantage of $2n-2$ degrees of freedom in controlling the second kind of error by taking

$$t=(x_1-x_2)\sqrt{n(1+\rho)}/\sqrt{(s_1^2+s_2^2-2\rho s_{12})}$$

II The hypothesis $\sigma_1^2=\sigma_2^2$

The test obtained by the likelihood ratio criterion or equivalent test $t=r\sqrt{n-2}/\sqrt{1-r^2}$ where $r=(s_1^2-s_2^2)/\{(s_1^2+s_2^2)^2-4s_{12}^2\}^{\frac{1}{2}}$ which follows t-distribution with $n-2$ $d\,f$ possesses all the properties of ordinary t-test when similar regions with respect to σ^2, ρ, m_1 & m_2 are considered

III Hypotheses concerning ρ

When the hypothesis is $\rho=\rho_0$, the critical region $|s_{12}/s_1s_2|\geqslant K$ is uniformly most powerful among unbiassed similar regions When the hypothesis is $\rho=\rho_0\neq 0$, the critical region given by one tail-end of $r=s_{12}/s_1s_2$ is a uniformly most powerful similar region when the alternatives include values of ρ on only one side of ρ_0.

When the equality of variances is further assumed, the information is utilised in improving the test which is supplied by $R=2s_{12}/(s_1^2+s_2^2)$

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OIL SEED CAKES AS SUPPLEMENTS TO SOUTH INDIAN RICE DIET

THE possible utilization of whole oil-seed cakes as sources of human food material has been the subject of study by several workers. The present food

shortage has led to the frequent suggestion that seed-cakes—particularly that from groundnut which is fairly plentiful—may be issued as a part of the food ration as it may serve as a supplement to poor rice diet The earlier work carried out at the Nutrition Research Laboratories, Coonoor[1,3] showed that groundnut cake has practically no supplementary value when added to poor South Indian rice diet This is highly intriguing, considering that groundnut protein is fairly complete and makes a good supplement to wheat diet[4] Before further investigating this aspect, it appeared to be necessary to first compare the different edible cakes to determine whether they all show a similar behaviour A comparative study of other oil-seed cakes like those from cotton-seed, sesame and coconut with that from groundnut as supplements to poor South Indian rice diet was therefore carried out

The method followed was exactly similar to that described by Aykroyd and Krishnan[1,2] Young rats 5-6 weeks old and weighing 40-60 gms , were divided into five groups, each group consisting of four rats, evenly distributed with regard to sex and litter-mates The rats belonging to Group I were fed on a basal diet ('Poor *Madrassi* Diet') the composition of which was that described by Aykroyd and Krishnan[1] The rats belonging to the other groups were fed on diets composed of the basal diet and supplements of the oil seed cakes in the proportions indicated.

The average weekly increase in body weight during a period of six weeks feeding with the experimental diets are shown in the following table together with the proportions in which the supplements were incorporated in the basal diet The supplements were added in such amounts that the total protein content of the experimental diet was nearly the same in each case (12 per cent)

Group	Experimental diet	Quantity of supplement in 100 parts of experimental diet	Total protein content of the experimental diet	Average weekly increase in weight of rats
			(%)	
1	Basal diet (South Indian diet)	—	8 68	2 5
2	Basal diet and groundnut cake	7 8	12 08	3 1
3	Basal diet and cotton-seed cake	20 2	11 97	6 6
4	Basal diet and sesame cake	13 4	11 93	6 1
5	Basal diet and coconut cake	27 2	12 02	7 5

The results show that, among the oil-seed cakes supplementing the South Indian diet and used at the same nitrogen level, coconut cake produces a marked enhancement of growth while groundnut cake has very little supplementary value. The latter finding is in complete accord with the findings reported from the Coonoor Laboratories[1,3] Cotton seed cake and sesame cake are also found to be good supplements to South Indian diet It is of interest to note that according to Jones *et al*[4], groundnut is a fairly good supplement to wheat diet, while our experiments and those carried out in the Coonoor Laboratories show that it is not a good supplement to South Indian diet composed mainly of rice

The values (6 1-7 5) obtained for the average weekly increases in the weight of rats fed on the South Indian diet supplemented with coconut, sesame and cottonseed cakes are comparable to those obtained by Aykroyd and Krishnan[2] for a 2 per cent supplement of dried yeast (7 2) and somewhat better than for a 7 per cent supplement of casein (4 1)

The foregoing results cannot however be regarded as being more than mere pointers to certain possibilities The separated proteins themselves were not compared, with the result that varying amounts of the cakes had to be used Assuming that the protein accounted for about 4 gms in each case, groundnut cake contained nearly the same weight of other matter , cottonseed cake contained nearly 16 gms of such substances, sesame cake over 9 gms and coconut cake over 23 gms There is need therefore to carry out systematic experiments with the separated proteins themselves Added to that, we have to investigate the cause of the extremely poor response shown to groundnut cake though the protein level in the diet was raised by about 50 per cent This can be clarified only by systematic metabolism studies These are already in progress and the results will be the subjects of subsequent communications

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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. DECEMBER, 1946 No. 6

In Memoriam :

IT is with a heavy heart that we record the passing away of MALAVIYAJI, a towering personality and the last of the 'old guard', after a short span of illness on Tuesday, the 12th November at 4-10 p m , at the Benares Hindu University, which was his home for more than quarter of a century

Born at Allahabad on December 25, 1861, of an ancient family of learned and orthodox brahmins, who emigrated from Malawa four centuries ago, Malaviyaji was the son of Pandit Brijnath Malaviva, an erudite sanskrit scholar

Malaviyaji received his early education at Sanskrit *Pathsalas*, and later was admitted to the Allahabad Zillah School, from where he passed the entrance examination in 1879 At the age of 15, he started reading the big and profound books in his parent's library and his appetite for knowledge was insatiable He obtained his B A degree of the Calcutta University in 1884, from the Muir Central College, Allahabad

Malaviyaji began his life as a teacher, in the Government High School at Allahabad on a monthly salary of Rs 50/- p m. The building up of the magnificent Hindu Hostel at Allahabad is an early instance of his ever active zeal in meeting the needs of the young

Soon after he took to journalism and since 1887, successively edited *Hindusthan*, *Indian Union* and *Abhyudaya*, (a Hindi weekly) with conspicuous ability He was till a few years ago connected with journalism as chairman of the Board of Directors of *Hindusthan Times*.

While he was serving the *Hindusthan*, he was induced by his friends and admirers to

PANDIT MADAN MOHAN MALAVIYA

Born. December 25, 1861. *Died*: November 12, 1946

study law and qualify for the bar He took the LL.B degree in 1892 and joined the Allahabad High Court as Vakeel in 1893 He was trained for the legal profession and with his gifts of lucid exposition and forensic skill might, if he had chosen, risen to the top of the profession. He, however, gave up a large practice and chose other fields of activity where service bring its own reward and the grateful plaudits of an admiring country

Early in his life he turned towards politics, and in 1886, he made his first appearance in the platforms of the Indian National Congress, which was holding its second session at Calcutta, with the late Dadabhoy Naoroji in the chair Young Malaviya made an impression as a speaker of considerable promise and the forecasts made then were amply fulfilled, for he had the unique honour of being called upon 4 times to adorn the presidential chair of the Indian National Congress which is in itself a rare tribute to the great esteem and trust in which the nation held him

For well over quarter of a century, he was a leading figure in Provincial and Central Legislatures He was a born orator with a notable felicity of expression and appeal in both Hindi and in English Some of his addresses *e g*, at the *Hindi Sahitya Sammelan*, All-India *Ayurvedic* and *Jyotish Conference* (the building up of a good astronomical observatory at the Benares Hindu University as adumbrated by Prof M N Saha in a memorandum to him was his oft-regretted unrealized project), the centenary celebration of Tulsidas, and the University convocations, often lasting for over two hours and delivered without any notes, were unforgettable feats remarkable for the range of information and especially his insight in the deeper spring of the ancient Indian culture and traditions.

He founded, and for years led, a number of organizations in order to inspire especially the youth of the nation with pride in the great culture and achievements of the Indian past His greatest work in this field, however, is the almost single-handed collection of well over a crore of rupees and the establishment of the Benares Hindu University, to preserve and popularize the ancient ideals at a confluence of the Hindu, Buddhist and allied cultures, a place which still echoes to the foot-fall of centuries of tradition and the tread of some of the greatest builders of Indian thought and civilization Spread in a pile upon pile of stately buildings in a single campus of some 2 square miles, housing over 30 departments and 12 colleges in the Faculties of Oriental Learning, Theology, Arts, Law, *Ayurveda* and Medicine, Science and Technology, and catering to the needs of over 4,000 students drawn from all parts of India—about 3,000 living together in the University hostels and adjacent lodges—the Benares Hindu University is a remarkable instance of what can be achieved by the unremitting pressure of an indomitable will joined to a noble purpose Malaviyaji was the Vice-chancellor of the University from 1919 to 1939 and was then appointed Rector for life He has left the world with this satisfaction that the seed he had sown bore fruits which enrich the country for generations to come

Pandit Malaviya has been an ardent champion of the *swadeshi* movement and took active interest in the industrial development in India He was associated with a number of industrial conferences and he contributed a good deal to the starting of the Prayag Sugar Company Ltd In 1911, Pandit Malaviya moved a resolution at the Imperial Legislative Council, which recommended the raising of the import duty on sugar, owing to the threatened danger to the industry by the annually increasing imports of sugar from Java An important discussion took place and this led to the establishment of the Coimbatore Sugar Research Station and the question of sugarcane improvement was seriously taken in hand

In 1916, the Government of India appointed the 'Indian Industrial Commission' for reviewing and reporting the possibilities of further industrial development in India, and Pandit Malaviya was invited to become a member of this commission The commission submitted its report in 1918, to which Pandit Malaviya appended a separate and valuable note. This is perhaps one of the first documents that stressed the need for research in scientific subjects for the development of Indian industries

In 1932, Pandit Malaviya attended the Second Round Table Conference in London along with Mahatma Gandhi He in his manners represented, as it were, the culture and unostentatious sophistication of forty centuries. But he was a brave man in the truest sense of the word. The country celebrated his 84th birthday on December 8, 1944 with much enthusiasm.

OUR NATIONAL CRISIS

EVERY one in our great country who has his own interest and that of his fellow men at heart must have felt extremely grieved, nay shocked, at the diabolical outbreak of communal hatred and bitterness, leading to violence and large scale massacre of innocent people, which have disfigured the history of this country at the present momentous epoch. These incidents have degraded us before the whole world, and have rendered the prospects of a peaceful betterment of conditions of living for the common man in this country an extremely remote one

To us scientists, it appears that this state of affairs has been brought about by highly placed people incessantly talking in an irresponsible manner only about those points in which the interests of the different sections of people appear to differ (we say appear, because actually they do not), and ignoring those in which everybody's interest is identical. The politicians of all sections talk of special rights, provincial and communal boundaries, reservation of offices and thousand and one safeguards and privileges which, however, cannot save the people from their chronic hunger, poverty and disease. For their selfish purpose they unscrupulously make use of religion and create friction, with the result that the minds of the people are cramped and their vision clouded. It has simply set the people to a mad race for shadows while losing sight of the substance sought for. We appeal to them to call a truce to these unprofitable talks and examine other more substantial and immediate problems, *viz*, problems of food, clothing, shelter, employment, education, health, and security, which are the common requirement of one and all in India today irrespective of his religion or province These require urgent, short and long term solutions. We need not add that our present position in respect of each one of these is frightful and distressing, but we wish to make it clear that they cannot be solved by mere political or economic slogans, but require hard thinking, to be followed by quick action In this way alone can we discover a *common purpose in life*, which can lead to unity of action and freedom from strife. 'Religions are many, but Reason is one', said the wise Chinese sage Confucius. Reason and truth which constitute the foundation of science can alone light our path and guide us to our destination of peace, progress and happiness, which we all strive for. There is no other way to salvation from disaster and ruin—moral, intellectual and physical, which stare us in the face.

Being absorbed in strife, due to the slogans which they have raised and which have now become dangerous superstitions, our political leaders are unconscious of the great economic and scientific forces which are gradually transforming the conditions of living for man in the world and fail to realize how much we are getting behind other nations in the struggle for an honourable existence on this globe. We need not enter into the polemical question whether India represents one nation or many nations, whether the Congress stand point is good or that of the League is better The fact remains that four hundred millions now living in the Indian continent have to live together and pool their resources together if a decent living for the common man has to be worked out The whole of India is dependent upon coal of Bihar and Bengal for the running of railways and factories all over India For a complete and balanced industrial and agricultural development which alone can give plenty to the common man, all the big rivers of India have to be developed for electrical power, irrigation, navigation and flood control These measures cannot be taken piecemeal, and rivers cannot be cut up in fragments to suit artificially created divisions Probably very soon atomic energy will have to be developed and used for running industries, and the whole of India will have to depend on Travancore supplies for thorium Roads and quick transport are very much needed, but India has discovered no sources of oil, probably, as has been found by the English and the Americans in Arabia, they lie hidden under thousands of feet of alluvia, and we have to mobilize thousands of scientists and technicians to track these resources and make them available for our use.

There are hundreds of other problems which have to be attended to, and our leaders can do a lot if they co-operate with the scientists and technicians and evolve a plan of action for immediate execution

It is scarcely a year that the war has come to an end. Although India had not the misfortune to meet the enemy forces directly in any part of her mainland, she was probably one of the worst sufferers from the consequences of the war. Our men fought in the deserts of the Middle East and in the jungles of the Far East Our hard earned money, that is, of the poor and half starved cultivators and workers, was freely loaned out to Britain till the latter found herself in debt to us to the extent of about Rs. 1,200 crores of rupees.

On the home front, terrible inflation, uncontrolled black-marketing, widespread corruption within the Government rank and without, evacuation and forced dislocation of rural people and a catastrophic famine which decimated the population of Bengal, according to official report, by about 2·5 million,

meant a suffering and hardship to the people, no whit less than what the people of any war-devastated country of Europe had to forbear In certain provinces, as in Bengal, education also suffered seriously on account of the abnormal war-time situation

There is not yet any symptom of our recovery from these evils. Very serious shortage of foodstuff, particularly the staple food grains like rice and wheat, still continues to remain a grave problem and may at any time precipitate a famine, as was recently apprehended over an wide area in Southern India Consumer goods of almost every description are also in short supply, and taking advantage of our weaknesses and shortcomings, ever watchful foreign manuturers and business concerns are already adopting subtle means to capture lost markets in India It is unfortunate that at such a critical time of our national existence, such anti-social, unnatural, and reactionery forces be let loose and allowed to strangle normal and peaceful activities as well as progress and development, leading to utter chaos and confusion.

Outside India, particularly in the United Kingdom, the U S S R, China, and the war-devastated countries of Europe, people have been enthused with a new spirit of post-war planning and reconstruction which may assure food, health, education, employment, housing, etc for all. Even during the darkest days of the war, as our readers are well aware, political and economic leaders, scientists and educationists in Britain planned for better education, better health, for greater expansion of trade and industry, and for more extensive scientific research, fundamental as well as applied, and the Government also responded to their recommendations with liberal financial provision In Soviet Russia, despite her dubious foreign policy, the people who have hurled back and defeated the Nazi Army are now busy with the equally important and no less difficult task of healing the wounds of war The Fourth Five-year Plan, or the First Post-war Five-year Plan, which has just been prepared, and following which work has already started, represents the courage, the vision and, above all, the unity of purpose of 160 million people of heterogeneous composition, divided, just 30 years ago, into a far larger number of nations and groups than present-day India and determined to build a wealthier and fuller life in their Fatherland.

Let us have a glimpse at some important items of this planning. In Soviet Russia, defeat of Nazi Germany has not been looked upon as an insurance against future aggression on her territory from the West. Accordingly, greater emphasis has been laid on the development of heavy industries, particularly the engineering industries. It is planned to double the pre-war output of machinery needed for making iron and steel, as well as for power, coal, and oil industries The proposed targets for iron, steel, rolled steel, coal and oil are 19 5, 25 4, 17 8, 250, 35 4 million tons as against the 1940 output figures of 15, 18 3, 166 and 31 million tons respectively By comparison with the 1940 figures, these targets appear modest enough , but they are not actually so During the German occupation, U. S S. R. lost a half of her coal and steel capacity and two-thirds in iron and her material destruction has been estimated at about 680 billion roubles. The attainment of this target would involve great and strenuous efforts as the Soviets have to build upon a seriously damaged and mutilated industry.

The plan envisages that the production of foodstuff and consumer goods would increase at the rate of about 17 per cent annually The target fixed for some of the important consumer goods, *e g*, paper, cotton, cloth, woollen cloth, leather boots and shoes are as follows. paper—1200 million tons, cotton cloth—4686 million metres; woollen cloth—159 million metres; and leather boots and shoes—240 million pairs. Output of these goods in 1938 stood at 832 million tons, 3491 million metres; 114 million metres, and 213 million pairs respectively

By the end of 1950, the total increase in the output in the whole Soviet industry, as envisaged in the plan, is expected to be about 48 per cent over that in 1940 The gross output, in items of money value, has been worked out to be 205 million roubles as against 138 5 billion roubles in 1940 As a result of this expansion in industry, the Soviet Union's net national income will rise from 128 3 billion roubles in 1940 to 177 billion in 1950 In 1932, her national income stood at 45 5 billion roubles only Thus we find that by 1940, it had trebled, and by 1950, if the Fourth Five-year Plan be satisfactorily worked out, this income would increase by four times in course of only 18 years In the history of planned economic development, there is hardly any parallel to such rapid rise in the national income, which is an infallible index of economic prosperity.

In India, during the war, the saner section of the intelligentsia have tried to impress upon the public and the Government the supreme necessity of planned development of resources in men and material as the only solution of our economic and other problems. Since 1938, we have been, through this journal, carrying on a vigorous campaign in this direction and in many respects it has also borne fruits. A great step was taken when the Congress set up the National Planning Committee, under the chairmanship of Pandit Jawaharlal Nehru, and composed of the country's most distinguished and capable scientists, economists and industrial leaders. The work of the Committee proceeded well and no less than 28 fact-finding sub-committees were appointed to collect statistics and frame recommen-

dations for the development of such subjects as industry—heavy and light, agriculture, power, employment, education, etc. The sudden incarceration of the chairman and other leaders unfortunately brought the activities of this Committee to a standstill But the idea never died, and later a group of industrialists of Bombay prepared a plan of economic development, popularly known as the Bombay Plan, which recommended a total investment of Rs 10,000 crores, to be spread over 15 years, for development of industry (Rs 4,480 crores), agriculture (Rs 1,240 crores), communications (Rs. 940 crores), education (Rs 490 crores), health (Rs. 450 crores), housing (Rs 2,200 crores), and miscellaneous (Rs 200 crores) The execution of the plan, the planners expected, would double the national income in fifteen years

The Government Departments also evinced great interest in the matter of planning, and attention was paid to such questions as education, food and agriculture, health, roads, railways, industry, etc. In 1943, the Advisory Board of Education prepared a post-war educational plan, associated with the name of Sir John Sargent. Dr Burn's report on the "Technological Possibilities of Agricultural Development in India" and Sir P M Kharegat's memorandum on the "Development of Agriculture and Animal Husbandry in India" have covered an extensive ground relating to food and agriculture Sir Joseph Bhore, chairman of the Health Survey and Development Committee appointed in 1943, has recently submitted a voluminous report (complete in four volumes), in which the whole field of public health and medical research in India has been surveyed and recommendations framed The short-lived and now defunct Planning and Development Department, under Sir Ardeshir Dalal, gave considerable thought to the question of industrial development and constituted a number of panels on heavy chemicals, light chemicals, electro-chemical, iron and steel, scientific instruments, sugar, alcohol and food, and several other industries Reports of the findings of some of these panels were also prepared An Indian Waterways, Irrigation and Navigation Commission and a Central Technical Power Board were constituted to make available expert advice on all problems relating to irrigation, river and power development A preliminary plan of multi-purpose development of the Damodar Valley, on the lines of the T V A , involving the co-operation of the Central Government and the Governments of Bengal and Bihar, has been submitted. A number of National Laboratories have been planned, and foundation stone of three of them has already been laid Recently the Government of India have established at Sindri in Bihar a Synthetic Fertilizer Plant

Thus, during the last five or six years, enough spade work and stock taking have been made in the direction of planning and development, although it was done, in many instances, in an unco-ordinated and haphazard manner We have now a fairly good idea as to the directions in which the country's efforts should be directed for economic regeneration New wealth will have to be created out of our abundant resources through the development of industries which will create new jobs and new avenues of employment. With this one object there cannot be any difference of opinion among the various communities To achieve freedom from want, from the scourges of preventible diseases, from the evils of illiteracy, all communities have to pull their resources and work together, notwithstanding their religious and social differences

As we make these statements we are fully aware that economic regeneration is impossible without political freedom. That freedom has so long been denied to us by a foreign government which has now, under pressure of events, come forward with a proposal—or should we call it a gesture—for transfer of power It is a pity that our communal differences, which have always given the ruling caucus in Britain a strong plea for remaining here, for creating artificial divisions, and engineering political deadlocks, should lead to such tragic events, which can only impede attainment of freedom and progress Political freedom is not the final goal, but only a condition for achieving economic and cultural prosperity of the people of this ancient land. We struggle for the attainment of this condition in order to be better able to organize our final struggle against poverty, malnutrition, illiteracy, unemployment and the like evils and build a happier, fuller and more prosperous life for the common man By fighting among ourselves, by preaching communal hatred and disunion, we are not only degrading ourselves as a nation before the world, but are perpetuating our notorious backwardness for an indefinite time

PLANETARIUM FOR EDUCATION AND ENTERTAINMENT

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THE study of starry heavens is fascinating to scientists as well as to the man in the street The movements of the sun, moon, planets and stars have not only provoked awe and wonder in man's mind, but have also been instrumental in evolving the fundamental laws of Mechanics The celestial motions have long been carefully studied by ancient people for determining season and sowing time, and have served long, even today, for finding direction in the sea, air, or desert Measurements of star-positions are extensively used today in survey mapping and precise location of a spot on the surface of the earth.

The study of the movements of the heavenly bodies has, however, been extremely difficult, involving complex calculations, since the motions, as observed from the earth, are complex in themselves Moreover, the motions are too slow to be perceived at all at a single gaze in one night So, the lover of the sky has to turn out to be either a hardboiled mathematician or a fantastic poet

But with the help of modern apparatus known as Planetarium, the study of heavens can be made more easy and enjoyable to all people

The most successful and interesting representation of moving sky is obtained through a modern optical "planetarium", which is a sort of movie of the stars and planets The planetarium theatre is a circular hall with a white dome-shaped screen at the ceiling overhead. The star projector is a complicated machine placed at the center of the hall The images of the stars, the sun, the moon and planets are focussed on the dome screen and turned with their various relative motions In the dark planetarium hall it gives the illusion of an open starry sky After the invention of optical planetariums in Germany, the Danish astronomer, Dr E Stroemgren, remarked of it: "Never has a means of entertainment been provided which is so instructive as this, never one which is so fascinating, never one which has such general appeal. It is a school, a theatre, a cinema in one ; a school room under the vault of heaven, a drama with the celestial bodies as actors."

Celestial Globes and Early Planetaria

Although the dynamic optical model of the heavens is comparatively new, the history of model representation of stars and planets on spherical globes is as old as 2000 years. It is said that a celestial globe was made or possessed by the ancient Greek astronomer, Eudoxus of Cnidus (c 350 B.C.) who, along with Plato, learnt his astronomy from the Egyptian priests at Heliopolis, Egypt A very fine globe is the Farnese Atlas, dating from Italian Renaissance times, which is the earliest complete representation of the sky that has been preserved A celestial and a terrestrial globe, prepared by Jodocus Hondius (1563-1611), a cartographer of Amsterdam, are preserved at the Huntington Library at Pasadena It is interesting that the celestial globe bears a small portrait of Tycho Brahe, marked as "Tycho Brahe, the famous mathematician"

Celestial globes are extensively used in class rooms, but it has the inherent defect that it represents a convex sky with man looking in the stellar world from outside. But, in reality, we feel that we are at the center of the starry sky which surrounds us. To obviate this defect, Erhard Weigel in Germany prepared (1699) a celestial globe made of thin metal foil and perforated it with needles with stellar configurations An observer would look at them not from above, but rather peep into it on the opposite wall through certain holes punched at relatively starless regions, thus permitting a view of the stars from the convex side of the model Tiny needle-holes permitting light from outside appear like glittering stars.

The idea of making large globes so that an observer can get inside and look at the stars painted or perforated around him is also quite old. The first of its kind was constructed about the year 1655 by Andres Busch of Limberg at the instance of Duke Frederick of Holstein-Gottorp. The hollow sphere was 11 feet in diameter with a central platform to accommodate 12 persons The stars were painted inside the globe and illuminated by a lamp in the center. The globe could be rotated by water power, without, however, overturning the platform which had a suitable mechanism to keep it always horizontal. About 1670 Erhard Weigel constructed one 10 ft. star globe like Busch's but added the features of reproducing the phenomena of meteors, rain, hail, lightning, thunder and volcanoes.

Most interesting of the large celestial globes was constructed by Professor Roger Long at Cambridge about 1758. This was 18 feet in diameter and could accommodate 30 people inside it The stars were punctured in the thin metal globe, as Weigel's, which gave very realistic likeness to the glittering stars with outside light coming through these perforations. The sphere could be turned by hand from outside.

The celestial globe was called "Urnium" by Professor Long. After infrequent use for more than a century, "Urnium" was offered to the Science Museum at South Kensington, London, as a gift But for some reason or other it was not accepted and unfortunately It was ultimately destroyed in 1874

In 1912 Dr Wallace W Atwood, then Director of the Museum of the Chicago Academy of Sciences, constructed a similar sphere of 15 feet diameter This has been generally known as the Atwood celestial globe

Besides the stellar globes, the solar system with moving planets was also reproduced on a model scale, Graham, inventor of the compensated pendulum, made such a planetary model for Prince Eugene of Savoy This was copied with some modification by John Rowley in an instrument prepared for Charles Boyle, for the Earl of Orrery This was very popular and widely known Since then such revolving models of solar system came to be called "Orrery"

In America several such orreries were made by David Rittenhouse of Philadelphia, one being preserved at the University of Pennsylvania A large orrery operates at the Hayden planetarium in New York Very fine orreries were constructed by Eise Eisinga in Holland, and by others toward the close of

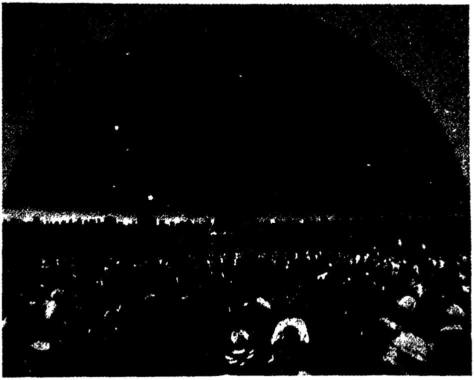

FIG 1 Interior of the Planetarium theatre during a lecture

which may be called the mechanical planetarium It is said that Archimedes (3rd Century B C) possessed a machine to reproduce the motions of the planets It is, however, difficult to justify the legend, and the quality of the model would now be considered questionable, inasmuch as it was of a time long before Copernicus (16th Century A D) who established the correct picture of heleocentric configuration of the solar system. The earliest mechanical and moving model of the solar system, preserved at Leyden in Holland, was constructed by the eminent French watchmaker Johannes van Ceuteh de La Haye in 1682 after a design by the physicist Huygens.

By the beginning of the 18th Century, George the 18th Century. A large orrery was put into operation in The Deutsches Museum in 1920 with Saturn's orbit 30 feet in diameter. At the earth's orbit it has a moving platform which carries the observer round the central sun once in 12 minutes, and gives the view of the planets as seen from the earth.

MODERN OPTICAL PLANETARIA

Modern optical planetaria take care of the stars, planets, sun, moon, milky way, zodiacal light and ther pehenomena of the sky and give a very realistic epresentation of the astronomical sky. The optical planetarium is an outcome (1924) of five years of research by Dr W. Bauersfeld and his associates at the Carl Zeiss factory in Jena. Its success in reproducing

the heavens was so remarkable that until recently the planetaria of almost all the countries were supplied by the Zeiss factory. The following list clearly shows the great popularity enjoyed by the Zeiss optical planetaria till the outbreak of the World War II

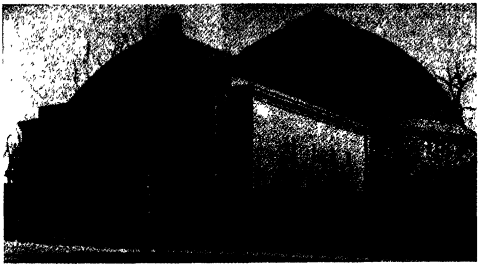

FIG 2 Berlin Planetarium (exterior view)

DISTRIBUTION OF ZEISS OPTICAL PLANETARIA*

Place	Date of Establishment	Diameter of Dome
Munich	July 5, 1925	33
Barmen	May 18, 1926	67
Leipzig	May 20, 1926	80
Dusseldorf	May 23, 1926	98
Jena	July 18, 1926	77
Dresden	July 24, 1926	82
Berlin	November 27, 1926	80
Vienna	March 7, 1927	65
Nuremberg	March 10, 1927	75
Mannheim	March 22, 1927	82
Stuttgart	April 16, 1928	82
Hanover	April 29, 1928	65
Rome	October 8, 1928	62
Moscow	November 5, 1929	82
Hamburg	April 15, 1930	67
Chicago	May 12, 1930	68
Stockholm	May 15, 1930	80
Milan	May 20, 1930	65
Philadelphia	November 6, 1933	66
Los Angeles	May 15, 1935	75
New York	October 3, 1935	75
Osaka	March 13, 1937	—
Paris	— 1937	—
Tokyo	November 2, 1938	—
Pittsburgh	October 24, 1939	65
Hague	—	—
Brussels	—	—

* From 'The Planetarium' by Roy K. Marshall, Franklin Institute.

Some Technical Features of the Optical Projector.—The Zeiss star projector is a complex apparatus with a "high order of optical technique, mechanical skill and astronomical knowledge merged in its design". The projector is an one-ton rotating machine carrying 105 projectors with 33 lamps and more than 500 separate lenses

The projector consists of two hollow globes 28 inches in diameter at the ends of a six feet skeleton trunk, resembling a big dump-bell The globes are made of thin brass (about 2 mm thick) and constitute the housings for 16 starfield projectors in each One of the globes carries the star fields of the northern sky, the other for the southern. Each star field projector consists of a thin copper foil (about 0 0006 inch or 0 015 mm) perforated with star designs of a small portion of the sky The perforations are made with different size punches to throw different brightness of the stars There are, in fact, 65 different sizes to represent stars between 1 to 6·5 visual magnitudes (brightness) in steps of 0 1 magnitude

At the center of each globe there is one 1000-watt lamp which feeds each of 16 star fields through their condensing lenses The image of the star field (perforated copper foil) is thrown on the dome through projector lens, Zeiss Tessar, 12 cm. focus, $f/2$ 66. The star field is magnified 80 times when it reaches the planetarium dome

Some of the stars have different light arrangements. For instance, Sirius, the brightest star of the sky, has a special lamp and casts a disc of light 2 inches in diameter on the dome. Although the star images are actually small discs of light of different sizes, the observer cannot discern the size at the

distance on the dome but can only perceive the difference by the brightness of the specks This is what is desired Three important variable stars, the Algol, Mira, and delta-Cephei, are provided with illumination control rheostats across their projection lamps at the demonstration desk. The milky way field is prepared by photographing a negative drawing and wrapping the photographed film on a cylinder with a projection lamp inside. The Magellanic clouds, Aurora, Zodiacal light, etc , are also projected by similar projections There are separate projectors for meteors, comets, and eclipses.

FIG 3 The Planetarium Projector

More complex mechanisms are provided for the planetary projections with complex relative motions These are housed in separate cages with gear box, etc , and have their respective optical projectors

The 105 projectors mentioned previously are distributed as follows

- 32 star field projectors
- 1 for Sirius
- 3 for variable stars
- 2 for Milky Way
- 7 for the sun, aurora, Zodiacal light, Gegenschein
- 2 for the moon
- 10 for the planets Mercury, Venus, Mars, Jupiter, Saturn
- 30 for constellation names, precessional circle
- 12 for equator, ecliptic, hour circles, parallels
- 4 for the medridian
- 1 for the year counter
- 1 for the latitude indicator

The planetarium sky can be turned at different speeds to make the model sky rotate in 10, 4 and 1 minute

In an optical planetarium "the heavens is portrayed in great dignity and splendour, dynamic, inspiring, in a way that dispels the mystery but retains the majesty"

THE FIVE OPTICAL PLANETARIA IN THE U S.A.

In this section, an attempt will be made to give an account of the five optical planetaria now functioning in the U S A Recently, the author had the previlege of visiting some of the U S planetaria and get acquainted with their history and work.

Soon after the perfection of the Zeiss planetarium projector in 1924, many museums and other public institutions in America sent their representatives to see the instrument and its performance Plans were made by several cities to establish planetaria as soon as possible Today there are five planetaria in America, at Chicago, Philadelphia, Los Angeles, New York, and Pittsburgh, with Zeiss projectors

The price of the projector is listed as 315,000 Reichmark, which is equivalent, in normal exchange rate, to about $75,000 or some Rs 2,25,000. The latest installation of the machine in America at the Buhl Planetarium in 1939 cost $134,000 The planetarium house would cost more than this amount

Adler Planetarium, Chicago —The Zeiss optical machine was first installed in America at the Adler Planetarium in Chicago in 1930 The founder and donor, Mr Max Adler, said in his presentation address

> "Chicago has been striving to create, and in large measure has succeeded in creating, facilities for its citizens of today to live a life richer and more full of meaning than was available for the citizens of yesterday Towards the creation of such opportunity I have desired to contribute . It is my hope that the youth of our city, and indeed of other cities, may through this dramatization find new interests and fresh inspiration and also that with the aid of the planetarium and astronomical museum, science may be advanced "

The Adler Planetarium and Astronomical Museum stands on the border of the beautiful lake Michigan, its steps reaching down to the waters. The building is almost round with 12 sides, exterior diameter being 160 feet The planetarium theater itself is 72 feet in diameter with a hemispherical dome 68 feet in diameter covered with white stretched linen making the projection screen The planetarium is air conditioned Round the central planetarium hall, the corridors and rooms are used as museum, office, bookstacks, instrument room, library, a small lecture room, etc. The lower floor has further museum space, a lecture room of 160 accommodation, instrument shop, photographic dark room, and air conditioning installations. There is a broad upper promenade deck which gives a wide view of the sky. Small portable telescopes are carried there on clear evenings for the demonstration of the sky to the visitors.

The average audience in the Adler Planetarium has been more than 150,000 visitors per year

The Fels Planetarium, Philadelphia.—This is the second installation in the U S A, operated since November 6, 1933. It was donated to the Franklin Institute by Samuel S Fels, soap manufacturer and philanthropist.

Apart from the usual feature of a planetarium, astronomical museum and lectures, the Franklin Institute has a pretty large roof observatory with two telescopes, one of them is a 10-inch refractor, the other a 24-inch reflecting telescope The 24-inch reflecting telescope happens to be the largest instrument in the world which is used exclusively for public instruction In the window, an image of the sun is sometimes projected by a vertical solar telescope to show sunspots, faculae and othe solar phenomena

The Griffith Observatory and Planetarium, Los Angeles.—The Observatory and Planetarium was a present to the City of Los Angeles given by the will of Colonel Griffith J Griffith, and was opened to the public in 1935.

The Observatory and Planetarium is situated on the beautiful summit of Mount Hollywood at an elevation of 1652 feet, giving also an excellent view of the City of Los Angeles and its surroundings

The planetarium theater has an accommodation for 514 persons and is often, especially during summer months, completely filled with visitors

The Hall of Science has a large number of exhibits, new exhibits are built and added from time to time. The observatory has a 12-inch Zeiss refractor telescope, and three solar telescopes—one of them projects magnified images of the sun on a screen in the exhibition hall. Among other exhibits a glass case contains amateur's hand ground telescopic mirrors

Meetings are held monthly at this institution for the purpose of discussing astronomical and telescope-making problems under the auspices of the Los Angeles Astronomical Society This society takes the present name since 1939 from its original nucleus, the Amateur Telescope Makers Society of Los Angeles, which was founded in 1925

The Hayden Planetarium, New York.—The planetarium is founded on the gift of Mr Charles Hayden (1870-1937) to the American Museum of Natural History. The planetarium was opened to the public on October 3, 1935. The size of the dome is 75 feet in diameter, made of stainless steel, and the hall has a seating accommodation of 733 persons. The hall is air-conditioned as elsewhere

Below the projection hall, the Hall of the Sun takes a large orrery The solar system moves on in tracks on the ceiling; the outermost orbit of the Saturn has a diameter of 40 feet.

The Hayden Planetarium has a number of beautiful mythological painting and sculpture on stone, astronomical exhibits and illustrations

The Buhl Planetarium, Pittsburgh.—This is the newest planetarium in the U S A., established in October, 1939, with the will of Mr Henry Buhl, Pittsburgh philanthropist and business man. The cost of the entire planetarium was $1,100,000, of which $134,000 was for the optical projector

The Buhl Planetarium and Institute of Popular Science has other interesting features and activities Besides the star projector, orrery, etc., it has a 10-inch horizontal refractor telescope inside a room, and is fed by optically flat mirrors which rotate with the sky to keep the starlight fixed in the telescope.

The Institute arranges series of popular lectures on physics, astronomy, biology, chemistry, and other sciences, and holds Annual Fairs on science exhibits A number of prizes and scholarships are awarded to best exhibitors.

One American-made Planetarium.—So far one optical planetarium has been constructed outside Zeiss, which is located at the Museum of Natural History, Springfield, Massachusetts, U S.A This is constructed by Frank D. Korkosz, museum technician, and operated toward the close of 1937 The dome of the Seymour Planetarium is 40 feet and has a seating capacity of 150. The projector, however, is not complete with planetary system, the elliptic and some other features of the Zeiss projector, "even without which the star projector is vastly educational" The projector consists of an aluminum sphere of 5 feet as diameter, set in its cradle and capable of rotating about the polar axis. The total height of the instrument is 7½ feet The light is projected from a 500 watt lamp inside the sphere through 42 objective lenses and star fields representing about 7,150 stars of the sky.

Bausch and Lomb Star Projector.—In 1943, Bausch and Lomb Optical Company at Rochester, U.S A, constructed a Star Projector which, unlike the full-fledged planetarium projectors, is much simpler in design and operation. This was primarily designed for training Navy men. Such an instrument has not yet been placed on the market, but it is hoped to be placed in course of time Such apparatus may be used as a general educational tool for teaching astronomy in schools, colleges, and in general astronomical lectures to great advantage. The projector consists of a metal globe about 3 feet in diameter with a fewer star charts and projection lenses. The globe is capable of rotation about its polar axis by a small electric motor. The revolving projector globe is half-immersed in a fixed metal globe so that star

lights are cut off below horizontal level. The center of the globe is aligned with the horizon plane of the projection dome-screen overhead

Planetaria or star-houses have assumed great importance in connection with astronomical education. Recently the Government of India have shown considerable interest in the development of astronomical studies in India Promotion of astronomical education will undoubtedly form part of any plan for future development of astronomy. The planetarium can greatly contribute to the furtherance of astronomical education in India and the attention of the Government may be directed to the desirability of establishing a number of planetaria at different parts of India *

* Acknowledgement is made to the U. S Planetarium authorities for their demonstrations, and kindly supplying information.

A NEW THEORY OF ATMOSPHERIC ELECTRICITY

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IN a recent issue of the *Soviet Journal of Physics* (Vol VII, No 5, 1944), Prof J Frenkel has given a new theory of the electrical phenomena in the atmosphere and the clouds. In view of the fundamental and highly suggestive nature of the ideas developed therein, it seems worth while to briefly discuss them here We feel that the theory may have still wider applications—it may be extended to dust storms (and electrification of powders injected into gases), we hope to discuss this aspect elsewhere *

Frenkel bases his theory on two broad facts The first is the ionization of air brought about by the ultraviolet radiations from the sun and cosmic rays and the second is the stronger affinity of water drops and ice crystals for negative ions over positive ones This property of water drops arises on account of water molecules possessing a permanent electrical moment. It is postulated that water molecules in the layers immediately below a free surface are characterized by their electric moments pointing (on the average) perpendicular to the surface. This results in the surface exhibiting a double layer, with negative charge outside and positive inside We may liken this double layer to a parallel plate condenser—the separation between the plates being a few molecular diameters—charged to a potential φ. The electrical work done by a drop in absorbing a positive charge e is $e\varphi$, whereas for a negative ion carrying an equal charge, the same amount of energy is liberated. Taking U to be the chemical energy of adsorption, which is the same for both kinds of ions, we have

$$U_+ = U - e\varphi$$
$$\text{and } U_- = U + e\varphi,$$

where U_+ and U_- are the adsorption energies for the two types of ions. Thus the adsorption energy of the negative ions exceeds that of the positive ones by an amount $2e\varphi$.

On account of the greater adsorption energy of negative ions, they have a stronger tendency than the positive ones to collect on the drop, and the adsorption continues till the greater affinity for the negative ions is counter-balanced by the work that has to be done on account of the repulsion between the negatively charged drop and the negative ions. This means that a water drop in equilibrium with its ionic atmosphere is charged to a potential ζ relative to the surroundings—ζ is called the electro-kinetic potential—and it is equal and opposite to the double layer potential φ. According to the work of Temkin, ζ for pure water is taken to be 0 25 volt $= 10^{-3}$ e.s.u. A water drop 10^{-3} cm. in radius will thus have a charge of 10^{-6} e.s.u., which is nearly 2000 electron charges.

The quantity of charge ζr, carried by a drop in equilibrium with the surrounding ionic atmosphere, gives only the average value. In fact, as is to be expected, the charge of a drop undergoes statistical fluctuations and the root-mean-square deviation, as derived from elementary arguments of Statistical Thermodynamics, is

$$\sqrt{r\,kT}$$

where k is Boltzmann's contant and T the absolute temperature. In case of rain drops ($r = 10^{-3}$ cm.)

* The treatment as given here is in some respects different from that of Frenkel's.

the magnitude of this deviation works out to be nearly 30 electronic charges; for smaller drops this quantity will be relatively larger.

A negatively charged water drop collects round itself an ionic atmosphere (Debye—Huckel) carrying an excess of positive charge to balance the negative charge of the drop. On account of the extremely small concentration of the ions relative to the number of (neutral) molecules present in the atmosphere, the extent of the compensating ionic cloud will be of a much larger order of magnitude than the mean-free-path of the ions. As a result of this feature, which is essential for the understanding of the electrical phenomena in the atmosphere, the ionic cloud is unable to follow the drop when it undergoes a displacement. The progress of the ionic cloud is controlled by the mobility of the atmospheric ions. This point is further discussed below.

As a first picture, which is admittedly crude, we consider each drop enclosed in a spherical cell of radius a, where $\frac{4\pi}{3} a^3 N = 1$, N being the number of drops per unit volume. The air in each cell contains a net positive charge which compensates the negative charge of the drop and, if the charge be assumed to be uniformly distributed in the cell, the charge density σ will be $\frac{3}{4\pi} \frac{qM}{r^3\rho}$, where M is the amount of the *liquid water* contained per unit volume of the atmosphere and ρ is the density of water. We shall for the time being assume a cell to be stationary and consider only the displacement of the water drop inside it. If the drop be displaced a distance ΔZ from the centre of the cell, it will be subjected to a restoring force $\frac{4\pi}{3}\sigma q\Delta Z$. It may be mentioned that under the influence of this restoring force, a drop will execute a periodic motion, the frequency of which is given by,

$$\nu = \frac{1}{4\pi\rho} \frac{\zeta}{r^2} \left(\frac{3M}{\pi}\right)^{1/2} \quad . \qquad (1)$$

This vibrational frequency ν for a drop of radius 10^{-5} cm is of the order of 10^3 per sec. Such vibrations may play a role in the absorption of sound travelling through a fog.

Consider a water drop at rest in the atmosphere. It will be displaced from the centre of its ionic cell by a distance ΔZ given by

$$m\, g = \frac{4\pi}{3}\,\sigma\, q\,\Delta Z, \quad . \qquad (2)$$

where g is the acceleration due to gravity and m the mass of the drop. The electric moment (axis directed upwards)* resulting from this displacement is

$$Q = q\Delta Z = \frac{q\rho r^2}{\zeta N}, \quad . \; . \; . \; . \; . \; . \; . \; . \; . \qquad (3)$$

and hence the polarization, *i.e.*, the electric moment per unit volume of the atmosphere is

$$P = Q\,N = \frac{\rho q r^2}{\zeta} \quad . \; . \; . \; . \; . \; . \; . \qquad (4)$$

and this gives rise (within the region) to the field

$$E_i = \frac{4\pi}{3} P = \frac{4\pi}{3} \frac{\rho g r^2}{\zeta} \quad . \; . \; . \; . \qquad (5)$$

A reasonable value for r is 10^{-3} cm and this gives $E_i = 1200 V/\text{cm}$. This value of the electric field is far larger than the observed values—it is about 10 times greater than the field usually found even in a thunder cloud. Even apart from this, the most disturbing feature of equation (5) is that it gives E_i independent of the concentration of the drops. The picture leading to relation (5) has, therefore, to be seriously modified—the modification will consist in discarding the assumption that the positive ions remain stationary. We speak of the positive ions alone because the negative ions would be negligible in number compared to the positive ones, these having been largely absorbed by the drops.*

We shall now proceed to take into account the motion of the positive ions, which were assumed to be at rest in the preceding discussion. As the drops sink under gravity, the electric field produced on account of polarization will act on the ions and they will, therefore, tend to move downwards. The (mean) velocity of drift of the ions increases with increasing displacement of the drops till it attains a value equal to the velocity of sinking of the latter. When this condition is reached, there is no further displacement between the drops and the ionic cloud, and the value of the polarization under these conditions is easily estimated. The velocity of drift of the ions in the electric field is $u = E\omega$, where ω is the mobility of the ions concerned. Since the number of positive ions is much larger than the negative ions, u may be taken to be the velocity with which the positive ions advance downwards.

Taking the limiting case, when the electric field acting on drops is negligible compared to the gravitational force, the velocity of the falling drops will be the terminal velocity as given by Stoke's law ($v = mg/6\pi\eta r$; η being the co-efficient of viscosity of air). Hence noting that $(4\pi/3)Na^3 = 1$, we have for the steady state, the field inside the cloud

$$E = \frac{2}{9} \frac{g}{\eta} \frac{r^2}{\omega} \quad . \; . \; . \; . \; . \; . \; . \; . \qquad (6a)$$

and as the conductivity λ of the air due to ions is $\lambda = \omega N q$, (6a) reduces to

$$E = \frac{Mg\zeta}{6\pi\eta\lambda} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \qquad (6b)$$

* The direction of the axis is taken from the negative to the positive charge.

* The following may, however, be noted in connection with the equation (5). In a homogeneous cloud the maximum electric polarization which can be produced is clearly comparable to $q\,N^{2/3}$, giving $E \backsim (g\zeta)^{1/3} M^{4/9}/P^{1/9}$. For a thunder cloud, taking $M = 10^{-6}$ gm./cc., E comes out to be nearly 1 V/cm

which may also be written as

$$E=\left(\frac{\Lambda Mgv}{\lambda^2}\right)^{1/2},$$

where, $\Lambda=(N\zeta^2 r/6\pi\eta)$.

Thus we find that the field as expressed in (6*b*) comes out to be independent of the size of the drops and proportional to $M\zeta$, if λ be taken to be constant M, throughout, represents the quantity of liquid water per unit volume and does not include the mass of water vapour present in the atmosphere, which is of the order of 10^{-5} gm /c c

Taking $M=10^{-6}$ gm /c c and $\lambda=10^{-3}$ e.s u, the average field within a thunder cloud, according to (6*b*), is found to be about 15 V/cm However, in certain parts of the cloud, on account of larger water content, the field may have values much higher than the average To calculate the field intensity near the surface of the earth, we put $M=10^{-7}$ gm /c c, and obtain 1 V/cm, as the value of the field, agreeing well with observations

Assuming for simplicity, the cloud to be a sphere of radius R, we can treat it as an electric dipole of moment $\frac{4\pi}{3}R^3P$ If H be the height of the cloud, it can be shown* that the total positive charge induced on the earth below the cloud amounts to $2P/3\sqrt{3}H$, and is confined within a circle of radius $H\sqrt{2}$ An equal amount of negative charge is induced outside this region.

Curiously enough, the rain drops (initially carrying a negative charge) on reaching the earth are found to be either neutral or charged positively This neutralization or the reversal of the charge is difficult to explain on the basis of the positive atmospheres round the drops, for, first, individual atmospheres do not exist for small drops, and, secondly, in case of larger drops, where such atmospheres are possible, they are not able to follow the sinking drops.

However, there are two possible ways by which the phenomenon may be explained One method, as suggested by C T R Wilson, takes into account the polarization of the drop due to the electric field. For simplicity, considering a neutral drop, it is easily seen that half of the drop is charged positively, while in the other half an equal amount of negative charge is induced Such a drop has a tendency to attract ions from the surroundings, but the conductivity of the positive ions being greater than for negative ones, the drop acquires a net positive charge However, this mechanism can apply only to larger drops, for in the case of smaller drops and ice crystals the polarization produced (being proportional to the cube of the radius) is very small

The second possible cause of the reversal in the sign of the charge may be due to a change in the magnitude and sign of the electro-kinetic potential ζ, owing to the contamination of insoluble organic molecules of the polar type Such molecules form a mono-layer on the surface of the drops with their axes oriented outwards Naturally the drops under these circumstances will have a tendency to adsorb positive ions in preference to the negative ones. During the process of coalescence, the effective surface area of a drop being reduced, the contamination density increases and in its turn helps the drops to acquire a positive charge

It appears that Frenkel's theory, though it needs to be developed in many respects, is an approach in the right direction and offers, at least qualitatively, a satisfactory explanation of some of the puzzling phenomena of atmospheric electricity

* The numerical factor given in the original paper seems to be incorrect.

THE RECLAMATION OF THE RAVINE LANDS OF THE JUMNA, UNITED PROVINCES

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SOIL is the real wealth of the cultivator By some authors it has been described as the most valuable mineral resource. This statement is made in comparison to the occurrence of gold, platinum, diamonds, etc These minerals are vanishing assets and once lost, cannot be replenished again, but soil in most cases has been cultivated from time immemorial. But its loss means the loss of the livelihood of the peasant, thus lowering his standard of living. In his Eighth Annual Message to the Congress, Theodore Roosevelt rightly remarked that "When the soil is gone, men must go and the process does not take long" The soil erosion is assuming alarming proportions in India and is proving a great menace and constitutes one of the major problems confronting this country.

It is familiar that the population of India is increasing and to meet the situation, there is an imperative necessity for increasing our food resources. Under the circumstances we can ill afford to lose any of our lands In some provinces, *e g*, the Punjab and Bombay, this problem is already receiving attention and it is hoped that the U P. and other provinces will also pay due attention to this urgent and important problem

It has been observed that the rapid erosion of soil is proceeding along the river Jumna and its tributaries and thus considerable acreage of arable land has been lost to agriculture Our endeavour should be not only to prevent any further erosion but to reclaim the soil already lost

With the object of drawing the attention of the public and the authorities concerned that the ravine lands of the Jumna can be and should be reclaimed without delay, the present communication is being made. These are days of conservation and reclamation and there is no reason why this country, with 388 8 millions to feed, should lag behind other countries

It is to be noted that these lands are almost semi-arid with rainfall varying from a little over 20 inches to less than 35 inches, which is again almost solely confined to the months of June-October. This rainfall can be almost torrential at times, while the soil is composed of soft alluvium.

The river is generally bounded by cliffs. In places they are 90 feet high but cliffs 30 to 40 feet in height, are quite common. The slopes, being somewhat steep near the river, are admirably suited for the action of rain and running water, and to begin with small gullies and ravines are formed. First, there may be the main ravine and subsequently lateral ravines develop and this process goes on repeating until the land is carved out into deep ravines which are lost to agriculture. Sometimes, above the cliffs a strip of land, about a quarter mile or more in width, is still under cultivation and there are small villages, but above the villages there are extensive ravine lands extending to a mile, mile and a half or even more on either side of the Jumna. Sometimes, these ravine lands may extend up to a distance of even five to six miles Similarly, along an important tributary stream the land is extensively ravined for a considerable distance It must be noted that if the mischief is once started, there is no end to it, unless it is effectively checked by some remedial measures

Of course, the comparatively more mature soil is lost by this erosion but the soil is fertile on the whole, being alluvial in character. It has a great depth and yields to cultivation The area, being semi-arid, much leaching has not occurred. The soil is generally a clay or a loam which is suited for the retention of water. It may be added that this erosion has exposed fresh alluvial soil.

IRRIGATION

The difficulty of the semi-arid lands is water, particularly for irrigation and the subsistence of live-stock This difficulty does not exist to any great extent as these lands have the benefit of tank irrigation, which has been supplemented by canal irrigation For instance, on the one-inch sheet 54 N/11 covering parts of the Cawnpore, Etawah and Jalaun Districts, extensive irrigation is available from the Bhognipur branch of the Lower Ganges Canal and its various distributaries These irrigation facilities could be supplemented and improved, if necessary. For instance, surface irrigation from the canals could be supplemented by tapping to a reasonable extent the underground resources of water. These two sources would be adequate for the purpose, otherwise by pumping water from the River Jumna at suitable places for purposes of irrigation would

almost convert the ravine lands, lying waste at present, into very good arable lands. It may be added that local relief, soil conditions, etc., offer least resistance to irrigation.

But in this connection it may also be noted that in semi-arid lands, where sufficient water is not available, drought-resisting crops are cultivated and the fields are prepared in such a way as to permit the maximum soaking of rain water. Of course on these lands greatest advantage should be taken of the monsoon rain by concentration on the *Kharif* crops, *e g.*, maize, millets, cotton, etc The first two not only provide corn for human consumption but good fodder for livestock also.

Water is a vital resource in all national economy, but particularly, as noted already, in semi-arid and arid lands The endeavour should be as much conservation of water as possible. It is familiar that an immense amount of water during the rainy season is permitted to go waste by allowing it to flow into the sea or inundate the neighbouring lands It would be highly beneficial if this surplus water is stored as much as possible by building storage reservoirs at suitable sites This water would not only be useful purposes of irrigation but also for generating hydro-electric power, so essentially needed for industrial and other purposes

RECLAMATION

There can be various means for the reclamation of these ravine lands In case of small holdings, even manual labour, *i.e*, the peasants themselves assisted by hired labour can terrace and ridge the ravine lands as is of course done on the sloping land in the hills. In places, sometimes even steeper slopes than those prevailing in the ravine lands have been brought under cultivation without any loss of soil. But in this case if the peasants themselves do not possess the financial means to accomplish this reclamation, a little aid from the Government would be certainly well deserved It could be even given as an advance which could be recovered by instalments.

For large scale and quick reclamation the use of machinery would be advisable. This method is already being tried in some parts of the Punjab There is both portable and fixed type of machinery and with the help of Bull dozer, etc, even some steep hilly waste lands have been levelled and reclaimed. It would be certainly advantageous to bring these ravine lands under agriculture But it has been found that in places these lands are under trees and grasses. As an alternative, some portions of these lands could be certainly afforested and grasses grown This cover of vegetation would certainly check further erosion Even the villagers themselves could help by planting quick growing and drought-resisting trees along with grasses The trees in course of time would provide them with the necessary timber and firewood, they need so badly and for which they burn their cattle dung, a very useful manure for their fields. The grasses, with proper control, could form the pasture lands for the cattle

THE GANGES

It is noteworthy that in the case of its sister but bigger stream, the Ganges, the ravine lands were found in a fewer places and on a much smaller scale as compared to those of the Jumna and its tributaries. The Ganges has a broad bed with shifting water channels It is also true that this river is raising its bed by the deposition of the sediments brought down by it from the mountainous regions. Consequently, during the monsoons, when the river is in spate, the spill water overspreads the adjoining lands and covers a large area forming marshes or swamps overgrown with grasses In this case the problem seems to be the proper drainage, training of the river by building embankments, so that no water is allowed to overflow and inundate the adjoining arable lands.

THE NARBADA

It may be noted that these ravine lands are not confined to the Jumna or the Ganges but they are developing in the vicinity of other rivers also. For instance, the author observed these ravine lands adjoining the Narbada river about 10 miles west of Jubbulpore *en route* to Shahpura In this neighbourhood the ravine lands are observed on both banks but on the right bank they extend to a distance of two miles or even more from the river Even farther upstream similar conditions are observed, and, in some places, it appears that the mischief is just beginning. If gully plugging or some like action is taken now, the trouble will be nipped in the bud, otherwise it is bound to extend with of course serious consequences later on. This instance will testify that these ravine lands are much more extensive than is generally known With the present trouble and with the growing cry for grow more food on every available piece of land (and even in normal times with about 400 millions people to feed), it becomes imperative that the various provincial governments with help from the Centre take immediate steps to reclaim these ravine lands, wherever they exist.

NATIONAL METALLURGICAL LABORATORY FOR INDIA

G P CONTRACTOR,
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

IT was during the last war that the Government of India realized that only planned industrial research on the many problems of the chemical, metallurgical and engineering industries could harness the country's vast resources for the prosecution of the war This realization was given effect to by the creation of the Board of Scientific and Industrial Research in April, 1940 and of the Council of Scientific and Industrial Research afterwards The Council was established, with Sir S S Bhatnagar as the Director of Scientific and Industrial Research, to meet the long felt need of a central organization for a co-ordinated prosecution of scientific and industrial research Shortly after the Government of India were pleased to sanction one crore of rupees for the establishment of a number of Research Laboratories to be sited in different parts of India

That India possesses great natural advantages for the production of iron and steel, there is no question She has rich and vast occurrences of iron ore, which exceed both in quality and quantity the ores found in many States of Europe and America These ores are reckoned to be more than sufficient for the requirements of the Indian iron masters for nearly 1,000 years In spite of this, India's yearly production of steel ingots and castings in 1939 was only one million tons U S A is producing ½ ton of steel per man, and United Kingdom about ⅓ and Japan 1/5 ton per man. In India if the target is kept as low as 1/50 ton per man, she will have to produce about 8 million tons of steel per year This comparison indicates beyond a shadow of doubt that India's iron and steel industry is in an utterly backward state A systematic and thorough development of the iron and steel industry, which is a basic and a key industry as well as a defence industry, could only facilitate the transition of India from the agricultural to the industrial stage by stimulating growth of a number of associated or allied industries.

In order to ensure the progress and expansion of the metallurgical industry it was decided by the Council that a National Metallurgical Laboratory be established in India. Accordingly, a Laboratory Planning Committee, under the Chairmanship of Sir J. J. Ghandy, Director, The Tata Industries, Ltd , was constituted to formulate a scheme The author was appointed the Assistant Director to assist the Planning Committee in the preparation of detailed plants, and Messrs Ballardie Thompson & Matthews of Calcutta were appointed the Architects. A tentative scheme was first circulated in 1945 The tentative scheme was later on drastically altered on the basis of the suggestions and comments received from research workers of repute in various countries, and principally on the basis of the funds available with the Council The final scheme was recently prepared and approved by the Governing Body of the Council of Scientific and Industrial Research.

The Laboratory will be located at Jamshedpur which is the centre of modern metallurgical industries in India The Tata Industries, Ltd , have generously placed at the disposal of the Council a very suitable site for the construction of the laboratory. Services, such as, electricity, water, gas, sewage and effluent disposals are available close to the site.

The Laboratory when completed will cover all aspects of metallurgical research, both fundamental and applied and will also carry out research on ores, minerals and refractories as applied to metallurgy The preparation of minerals and ores and the smelting of the latter are so definitely a part of the development of the country's metallurgical industries that facilities for mineral research have been provided at the Laboratory, complete with pilot plant equipment for semi-commercial development

As the metallurgical industry is one of the biggest consumers of refractories, research on this subject has also been associated with that on metallurgy, and that the work on metallurgical furnace design might also be undertaken.

The Laboratory is meant to function as an up-to-date research centre where knowledge of the fundamental sciences of physics, physical and inorganic chemistry, metallography, engineering, etc , will be utilized to solve the problems which confront the ferrous and non-ferrous masters and metal fabricators to-day and are expected to confront them even more in the future when competition from foreign countries will have to be met. The Laboratory is also meant to function as a clearing house for information The Laboratory will give facilities to a number of scholars to an advanced course and will train them in the application of scientific methods to metal industries, so as to enable them to take charge of technological duties in the works To help and encourage industrialists in the solution of their problems facilities will be provided at the Laboratory by establishing a Fellowship System, first inaugurated at the Mellon Research Institute, Pittsburgh

The Laboratory will consist of a Main Building housing administrative offices, research laboratories, library, lecture theatre, museum, etc , and a Technological Block comprising large workshop type laboratories or bays associated with control rooms for semi-commercial scale operation The Main Building will have three floors. The administrative section is centrally located on the second floor The actual working floor area on the first floor is approximately 26,000 sq. ft., with an equivalent space on the ground floor and about 8,600 sq ft , on the second floor The Technological Block providing a working floor area of about 28,000 sq ft , has been situated to the south of the Main Building and connected to it by covered ways.

The total cost of construction and equipment is estimated to be Rs 42 8 lakhs. Out of this, the grant from the Government of India is Rs. 30 lakhs and the balance of Rs. 12 8 lakhs is from donations the most important of which are the magnificent contribution of the noble House of Tata of a sum of Rs 11·7 lakhs and a donation of Rs 1 lakh from Sardar Bahadur Sir Inder Singh of Jamshedpur The Council have also received a donation of Rs 10,000 from the Indian Metallurgical Association for the purpose Buildings, services, heavy electrics, air-conditioning, etc , are estimated to cost Rs. 25 lakhs and for equipment a provision of Rs 17 8 lakhs has been made The recurring expenses in the initial stages are approximately estimated at Rs 6 lakhs.

PHYSICS OF DIAMOND

THE *Proceedings of the Indian Academy of Sciences*, July 1946, contains a number of papers embodying the results of researches on the physics of diamond, carried out in the Physics Department of the Indian Institute of Sciences, Bangalore These researches form the part of the programme of work undertaken by Prof. C V Raman to investigate into the structure of diamonds from all possible angles of attack, and were reported in the second symposium on the structure and properties of diamond

The symposium began with a paper, by Prof C V Raman and S Ramseshan, in which were described the conclusions reached from a critical examination of some seventy-two diamonds from different sources in their natural forms. From a comprehensive consideration of the curvature of the faces and some other special features, Prof Raman has shown that the crystal symmetry of majority of diamonds is best described as that of the tetrahedral class instead of the standard terminology of geometrical crystallography ; the possibility that diamond, in some cases, may have a truly octahedral symmetry of structure, although not exhibited by its external forms, is not, however, excluded by the observed facts.

Dr R. S. Krishnan has re-examined the Raman spectrum of diamond, of the ultraviolet transparent type, with Hg $\lambda 2536\ 5$ as exciter with improved experimental technique permitting greater intensity and higher resolution The second order Raman spectrum obtained by him exhibited ten weaker but distinct Raman lines besides the one previously reported The set of five absorption peaks in the infra-red region observed by Robertson, Fox and Martin correspond very closely to the frequency shifts of the first five lines The more prominent and intense Raman lines have been identified as octaves of the important lattice frequencies that appear in the luminescence spectra of diamonds It is stated that these facts can be explained on the basis of Prof Raman's theory of the dynamics of crystal lattice

Dr R S Krishnan has also studied the temperature dependence of the principal Raman frequency in the temperature range 85°T to 975°T and has obtained identical results for both ultraviolet transparent and opaque types with Hg 2536 5 as well as Hg 4358 excitation The more prominent ones of the second order Raman lines have also been studied in the temperature range 30°C to 620°C. The different behaviour of the various lattice and super-lattice frequencies in respect of their temperature variation has been attributed to the difference in the temperature coefficients of the corresponding force constants determining the vibration frequencies of the lattice. The width of the principal Raman line has been found to increase with temperature, the magnitude of which can be explained as due to thermal fluctuations of lattice spacings causing corresponding changes of lattice frequency if the effective linear dimensions

are assumed to be about eight times as large as the edge of the unit cubic cell.

The coefficient of thermal expansion of diamond in the temperature range 28°C to 605°C has been measured by Dr R S Krishnan using the X-ray method and reported in a separate paper.

Mr G. N. Ramchandran is responsible for four papers: (1) On the crystal symmetry of diamond and its X-ray reflection; (2) Nature and origin of the laminations observed in diamond, (3) Luminescence of diamond excited by X-radiation, and (4) Topographs of diamond—part II In (1) he discusses the structure of diamond as revealed by its X-ray pattern wherein he shows that the X-ray behaviour of the crystal does not uniquely decide whether the symmetry is tetrahedral or octahedral and he further indicates the possible structures in both cases In (2) study of the geometric characters of the birefringence for thin plates of diamond and the areal variation of its order have been reported, the observations indicate the existence of oriented laminations under strain inside the crystal, and the difference in the nature of laminations for various specimen supports the ideas of Raman that there are two varieties of diamond even among the ultraviolet transparent types In (3) the author records his investigation on the X-ray luminescence of different types of diamonds, which includes his studies on the luminescence spectra, intensity of luminescence and its dependence on the wave length of X-rays, quantitative formulae have been developed to explain the experimental data In (4) the area mapping of diamond plates by its X-ray reflecting power has been continued, the results indicate a correlation between X-ray reflecting power and the intensity of luminescence besides showing a correspondence with the birefringence patterns

The study of the Faraday effect and the cleavage properties of diamond has been reported separately by S. Ramseshan in a third paper, the same author has explained various features of the crystallography of diamond on the basis of the ideas, originally due to Prof C V. Raman According to these, diamond retains much of its shape of the liquid drop during the process of its solidification from liquefied carbon under pressure and as such its shape is controlled by the non-random orientation of the valence bonds between the carbon atoms, causing direction-dependent surface tension of the molten liquid.

The four papers relating to the absorption of diamond crystals in the visible, ultraviolet and infra-red regions are due to K G Ramnathan In the visible and ultraviolet region, he has obtained new results; the author has also provided an interpretation of his observations in the infra-red regions in the light of Raman's theory of diamond structure

Thermoluminescence, phosphorescence and phosphorescence patterns in diamonds have been investigated by V Chandrasekharan, the results of which form the subject matter of the three papers in the symposium In another paper by G N Ramchandra and V Chandrasekharan, the doublet centred at 4152Å occurring in the fluorescence spectra of all diamonds has been shown to be due to a forbidden transition similar to $^3P - ^1S$ of CI

The symposium includes reports of the study on the local variations in the photo-conductivity of diamond and geometric patterns of fluorescence in diamond by K. Achyuthan and G. R. Rendall respectively.

H. N. Bose.

Notes and News

FUEL RESEARCH INSTITUTE

ON November 17, 1946, Mr C H. Bhabha, Member for Works, Mines and Power, Government of India, laid the foundation stone of the Fuel Research Institute at Digwadih, 10 miles from Dhanbad, in the heart of Bihar's industrial area. In the July, 1946 issue of SCIENCE AND CULTURE, we have published an account of the brief history of planning for the Institute, the scope of fuel research in India, the various divisions of the Institute and the financial aspects, shortly after we received the text of the Plan for the Fuel Research Institute of India, as prepared and submitted by the Council of Scientific and Industrial Research We are glad that the Institute which is expected to play an important role in future industrialization of the country by directing research and investigations on such a vital national commodity as coal and other fuels has at last seen the light of day In his inaugural speech, Mr Bhabha emphasized that coal was the most important fuel both for domestic and industrial purposes and was besides the basic raw material on which a number of other industries depended When many of India's basic industries, not yet organized and developed, came to be established, he observed, there would undoubtedly be a heavy strain on our coal resources, leading to a critical situation which should be visualized and taken adequate care of from now. With regard to the all-important question of the nationalization of coal, Mr Bhabha remarked, "Nationalization of such an important industry as coal cannot be brought about overnight, despite its acknowledged necessity and advantages The industry has numerous ramifications which must be taken into account in determining the type of planning that we have to embark on in the interests of national welfare. It is fundamentally the striking of a balance between central authority and pioneering endeavour" So far as the Government is concerned, he assured that 'the problem of coal will soon engage the earnest attention of the National Government and the various suggestions put forth in the interests of the industry and in the interests of national welfare will receive all the consideration they deserve.'

In his address, Sir S. S. Bhatnagar referred to the well known Indian Coal Fields Committee under the chairmanship of Mr K. C. Mahindra, appointed by Sir Ardeshir Dalal, then Member of the Viceroy's Executive Council in charge of the Department of Planning and Development In their report recently submitted to the Government of India, the Committee have brought out the importance of the nationalization of coal industry in India, of setting up a separate department of fuel and power, and also of the establishment of a National Fuel Board vested with powers to control production, distribution and utilization of coal. With a view to creating wider facilities for technical research on coal, the Committee have recommended the setting up of three research sub-stations in the Raniganj, Bokaro and the C. P. coal fields in addition to the Central Fuel Research Institute at Digwadih

NATIONAL METALLURGICAL LABORATORY

CLOSE at the heels of inauguration of the Fuel Research Institute at Digwadih has come the news of the inaugural ceremony of another important national laboratory, the National Metallurgical Laboratory, whose foundation stone has been laid at Jamshedpur on November 21 by Mr C. Rajagopalachari, Member for Education, Government of India. A brief account of this Laboratory which is the third in the chain of India's five National Laboratories (the remaining two being the National Physical and the National Chemical Laboratories) planned by the C. S. I R. is given in an article by Dr G. D Contractor, Assistant Director of the Laboratory, published elsewhere in this issue

Mr Rajagopalachari, in his address, particularly referred to the backwardness of India's metallurgical industries In spite of her sizeable iron and steel industry, he deplored, India was entirely dependent on other countries for supplies of high-speed tool and alloy steels, aluminium, magnesium, various ferrous and non-ferrous alloys and their products. "In consequence, engineering industries, the manufacture of internal combustion engines, electrical industry, ship-building, air-craft, chemical industries, and several other important industries, which depend on metallurgy for the supply of the necessary constructional material, have not grown up in the country." India is, however, rich in several minerals of economic value, such as bauxite, chromite, manganese, monazite and ilmenite, not to speak of her abundant resources in clay, limestone, iron ore and gypsum. He recognized the indispensability of deve-

loping electrical power as a pre-requisite for the growth of metallurgical industries The various hydro-electric projects, when they come to fruition, will make available hydro-electric energy at the rate of about 4 million k w With cheap and adequate supplies of electrical energy alone can we actually expect to reach our immediate target of 20,000 tons of aluminium, 5,000 tons of magnesium, 15,000 tons of copper, 60,000 tons of electric furnace steel per year, and large quantities of other electro-thermal products like alloy steels, ferro-chrome, ferro-manganese, ferro-silicon, graphite and carborandum

There is no doubt that the National Metallurgical Laboratory can play a very effective role in all these developments But the planning of the Laboratory has progressed during all these years with such a speed that there is little to be expected if things continue in the same fashion also in future. We find from a careful perusal of the Report just issued that, as early as December 7, 1940, the desirability of establishing a National Metallurgical Research Institute was first recommended at the first meeting of the Metals Committee The recommendation was approved of by the Council of Scientific and Industrial Research and a Laboratory Planning Sub-Committee, with Sir J J. Ghandy as Chairman, was later constituted. This Sub-Committee submitted its preliminary report on May 1942, and its final report shortly after In October 1944, the National Metallurgical Laboratory Planning Committee was appointed to attend to detailed planning, and in November 21, 1946, the inauguration of this Laboratory has been announced Thus the Council have taken full six years for the planning and announcement of the formal establishment of the Laboratory, and we do not know when the organization of the Laboratory will be complete and will reach a stage at which practical problems of the metallurgical industry can be effectively dealt with.

Moreover, it appears from the report that the detailed working of the plan was entrusted to and carried out by Messrs Ballardie Thompson and Matthews, the Architects, 'as the majority of its (Planning Sub-Committee's) members were busily engaged on work of national importance due to war' and 'the Sub-committee considered that a firm of architects be engaged to translate its recommendations into definite plans'. Messrs. Ballardie Thompson and Matthews, although good architects, are certainly not a body of metallurgical experts, and their competence for this work is clearly questionable There is still a good deal of muddle-headedness in most of these Government plans, however, well intentioned, and the earlier there is an end of it under the inspiring atmosphere of the Provisional National Government, the better for the country.

INDIAN SCIENCE CONGRESS

The 34th Annual Session of the Indian Science Congress Association, originally scheduled to be held at Patna, will be held at the University Buildings, Delhi, from January 2 to January 8. Pandit Jawaharlal Nehru, Vice-President of the First Provisional National Government of India, will preside over the session

The presence of a number of foreign visiting scientists of international fame will be one of the greatest attractions of the 1947 session of the Congress. Information has reached us that a large number of distinguished scientists from the U. K., the U. S A, the U S S R, France, Belgium, China, Egypt, Denmark, Switzerland and possibly also from some other countries have been invited to attend the session We are glad to learn that Sir Henry Dale, Sir Robert Robinson, Sir Henry Tizzard, Sir Charles Darwin, Prof P M. S Blackett, Prof Gray and Dr Julian Huxley, Executive Secretary of the Preparatory Commission, UNESCO, are among those British scientists who have already cabled their willingness to come to India. The Danish Legation has informed that Prof. Niels Bohr might also attend the session Prof F Joliot and Hadamard are expected from France Besides, the Presidents of the National Academy of Sciences at Washington, the Royal Society of London and the Royal Society of Canada have also agreed to send delegations to India The foreign delegates are expected to spend a couple of months on touring and lecturing in India

It is understood that the Executive Committee of the Association are organizing a special symposium on National Planning, with Pandit Jawaharlal as the president This symposium will be attended by distinguished scholars, scientists and administrators from all over India, and the deliberations are likely to lay the foundations of large-scale programmes of national development by the State and Indian industries.

The Education Department, Government of India, has been pleased to sanction a sum of Rs. 75,000 towards expenses of the visiting scientific delegations from abroad Efforts are now being made to see that the passages of the scientists from the U. K. and the U. S A are paid by such organizations as the Royal Society in England and the Rockefeller Foundation and similar bodies in America.

Sir S. S Bhatnagar and Prof D S. Kothari are acting as local secretaries, to whom all questions regarding local arrangements such as accommodation, etc. should be referred. The following are the sectional presidents :

Mathematics—Prof D. D. Kosambi, D Sc , Tata Institute of Fundamental Research, Bombay

Statistics—Mr R C. Bose, M.A , F.N I., Head of the Department of Statistics, Calcutta University

Physics—Dr K Banerjee, D.Sc, F N I, Mahendra Lal Sircar Professor of Physics, Indian Association for the Cultivation of Science, Calcutta

Chemistry—Dr P K Bose, D Sc, F N I, Director, Indian Lac Research Institute, Ranchi

Geology and Geography—Dr C S Pichamuthu, Ph D, F R.S E, F G S., F N I, Principal, Intermediate College, Bangalore

Botany—Prof A C Joshi, D Sc, F N.I, Head of the Department of Botany, Government College, Lahore

Zoology—Dr G D Bhalerao, D Sc, Ph D, Officer-in-Charge, Veterinary Zoology Section, Imperial Veterinary Research Institute, Izatnagar

Anthropology—Dr (Mrs) Irawati Karve, M A, Ph D, Reader in Sociology, Deccan College, Poona

Medical and Veterinary Sciences—Prof G Panja, M B (Cal), D Bact (Lond), F N I, Professor of Bacteriology and Pathology, School of Tropical Medicine, Calcutta

Agricultural Sciences—Mr N L Dutt, M Sc, Govern-Sugarcane Expert, Imperial Sugarcane Station, Coimbatore

Physiology—Prof S A Rahman, Professor of Physiology, Osmania Medical College, Hyderabad (Deccan)

Psychology and Educational Science—Mr P S Naidu, M A, University Reader in Education, Allahabad University

Engineering and Metallurgy—Mr H P Bhaumik, B A, C & E E (Roorkee), O B E, M I E, Past President, Institution of Engineers (India), Calcutta

SCIENCE AND UNESCO

THE Preparatory Commission of the United Nations Educational, Scientific and Cultural Organization have recently issued a pamphlet "Science and UNESCO" in which the Commission's proposals regarding the tasks and functions of the Secretariat's Division of Natural Science have been fully detailed These functions have been classified under two headings, (A) Temporary, and (B) Permanent The temporary functions include rehabilitation of science in the war-devastated countries, and the permanent functions cover the whole range of activities calculated to promote international co-operation and goodwill among scientists of all nations in all aspects The following is the text of the aims and functions of the Division of Natural Sciences

A *Temporary*

(1) Assist the restoration of scientific facilities in the war-damaged countries.

B. *Permanent.*

(1) Promote international scientific co-operation in all its aspects, by facilitating the work of existing international scientific organizations, by initiating new ones if necessary, and by setting up regional science co-operation offices throughout the world (cf. Constitution, Art. I, sect. 2 (*c*))

(2) Organize and assist the better exchange of scientific information and research services between scientists and their organizations in the different countries.

(3) Assist the free flow of essential research apparatus, chemicals, and equipment across national boundaries, as also the exchange of scientific specimens ; collections of animals and plants, mineralogical samples, roots, seeds, and the like

(4) Assist the free flow of scientific books, periodicals, micro-films, cinema films, manuscripts for publication, translations, abstracts, radio talks, etc, across national boundaries, and especially between world regions of widely different linguistic pattern, *e g*, those of the ideographic and alphabetic languages

(5) Assist the free flow of scientists coming and going across national boundaries, whether for periods of study and research, or for congresses, conferences, and the like

(6) Promote international collaboration in scientific research, by aiding the work of already existing groups, initiating new forms of co-operation, instituting international observatories and laboratories, supporting model projects of symbolic as well as concrete significance, and facilitating the international activities of the various National Academies of Science.

(7) Assist in maintaining contact between government organizations concerned with science, pure and applied, when necessary, and advise governmental and diplomatic personnel on scientific matters, when desired

(8) Co-operate with the work of the Economic and Social Council of UNO, and of the Trusteeship Council of UNO

(9) Co-operate with the work of all other United Nations organizations and agencies, such as the United Nations Food and Agricultural Organization, the United Nations Atomic Development Authority (when set up), the International Labour Office, the International Health Organization, the United Nations Relief and Rehabilitation Administration, the International Civil Aviation Organization, the International Resources Office (if formed), etc, in scientific questions

(10) Assist and correlate the work of the smaller or more specialised international scientific bodies already existing, both inter- and non-governmental, such as the International Bureau of Weights and Measures, the International Time Bureau, the International Standards Co-ordinating Association, the International Commission on Zoological Nomenclature, the International Anti-Locust Rsearch Centre, the International Council for the Exploration of the Sea, etc, etc.

(11) Co-operate with the United Nations Information Service and the Division of Press and Publicity in UNESCO in informing the public in all countries

concerning the bearing of scientific discoveries on international relations, and urge the improvement and extension of the teaching of science in all schools throughout the world

Each of these items have been fully explained in the body of the pamphlet

THE CENTENARY OF THE CHEMICAL SOCIETY

THE Chemical Society is to celebrate the centenary of its foundation in July, 1947 But for the war the celebrations would have taken place in 1941, for it was "on the 23rd February, 1841, that twenty-five gentlemen interested in the prosecution of chemistry met together at the Societcy of Arts to consider whether it be expedient to form a Chemical Society", and the Chemical Society was born It was the first Society formed solely for the study of chemistry and although there had been small private chemical societies before 1841, none lasted for any great length of time. At its first general meeting Thomas Graham, the most distinguished chemist of his time, the pioneer of colloid chemistry and a discoverer of much important new chemical knowledge, was elected the first President The organizer of the meeting on 23rd February, 1841, and the Society's first Secretary was Robert Warington. These two men were the leaders of the new Society and among its present day possessions one of the most valuable is the 100-year old Obligation Book which is still signed by new Fellows on their admission and contains as its first signatures the names of these two pioneers.

The Fellowship of the Society, of which Professor C. N Hinshelwood is the present President, has grown from those twenty-five gentlemen in 1841 to over 6,000 The study of chemistry as a whole has remained its object ; because of this the Society has always maintained a special place in the world of chemistry It has not pursued the purely professional nor has it specially fostered industrial chemistry although many great industries have been based on fundamental discoveries made by its Fellows. The professional affairs of chemists are now the province of the Royal Institute of Chemistry (founded in 1877) and industrial chemistry is the concern of the Society of Chemical Industry (founded in 1881). Both these organizations were offshoots of the Chemical Society; as were other societies specializing in sub-divisions of the subject. Today some of these offshoots, having meantime grown in stature and importance, are again joined with the parent body in the Chemical Council, which consists of representatives of various chemical organizations and through which chemical industry and individuals subscribe to provide assistance in the publication of chemical research and information. Success has from the first attended on the Chemical Society and has been due almost entirely to the ready means it has provided chemists of publishing their discoveries and affording them a place for discussion and mutual interchange of ideas.

The science of chemistry has made great advances since 1841 , to which the Fellows of the Society have contributed in no small measure. Graham, Hofmann, Williamson, Edward Frankland, Odling, Gilbert, Sir William and W. H Perkin, Crookes, Ramsay, Dewar, Armstrong, Meldola and Pope, Fellows and past Presidents of the Society, were all associated with fundamental chemical discoveries of far-reaching importance The discovery of mauve by Perkin led to the growth of the present day coal tar industry embracing dyestuffs manufacture, synthetic medicinals, the photographic industry and much more The pure research on the growth of plants by Gilbert and Lawes at Rothamsted formed the basis of the vast present day synthetic fertilizer industry. The cathode ray tube of Crookes is the direct ancestor of the present television screens, the thermos flask of Dewar is one example of the application of Dewar's low temperature experiments and neon display signs are but one instance of the use man has made of Ramsay's epoch-making discovery of the rare gases

It is fitting that the Society, with such a history and with its present day virility, has decided to celebrate its centenary in a suitable way The importance was indeed internationally recognized in the decision taken in Rome in 1938 by the International Union of Pure and Applied Chemistry to hold its next International Congress in London at the time of the Centenary of the Chemical Society. This decision is to be implemented next year and immediately following the celebrations on July 15th to July 17th 1947, the Eleventh International Congress of Pure and Applied Chemistry will also take place in London.

An international outlook has always been characteristic of the Society and this will be reflected in the series of social and scientific events which will constitute three days of celebrations. Many distinguished overseas delegates are to be invited These will include the Honorary Fellows of the Society, among whom are the world's greatest chemists of today. One of these distinguished visitors will be invited to follow in the line of Dumas, Cannizzaro, Wurts, Mendeleef, Ostwald, Fischer, Richards, Arrhenius, Bohr, Debye, Rutherford and Langmuir as the Society's Faraday Lecturer The Faraday Lectureship was founded in 1867 to commemorate the name of Michael Faraday, who was elected a Fellow of the Society in 1842 and was one of its Vice-

Presidents. In addition to the Faraday Lecture, it is intended that there should be a centenary address and a formal ceremony for the presentation of addresses. It is also hoped to arrange a number of scientific lectures, visits to places of interest in the London area and an exhibition which will be at the Science Museum during the period of the celebrations and the International Congress

NUFFIELD FOUNDATION FELLOWSHIPS AND SCHOLARSHIPS FOR THE ADVANCEMENT OF EXTRACTION METALLURGY

NOTICE has been received that the Nuffield Foundation, which has already done much to aid medicine, has just inaugurated a scheme with the object of advancing research and training in extraction metallurgy The scheme is in three parts

(*a*) Five Travelling Fellowships are being offered each year to members of the teaching staff of universities and approved schools of mines and metallurgy within the Commonwealth and Empire The object of this scheme is to enable teachers to visit important mining and metallurgical centres in the Empire in the long vacation in order to study the methods employed in those centres The value of each fellowship will be up to £500 including the cost of travel The duration of each fellowship will be approximately three months

(*b*) Five Travelling Postgraduate Scholarships are being offered each year for junior members of the profession who are graduates of universities and approved schools of mines and metallurgy in the Commonwealth and Empire and who have specialized in extraction metallurgy Candidates will be selected not necessarily on account of their order of merit in examinations, but with regard also to their personality and general suitability

The value of a scholarship will be up to £500, including the cost of travel. The duration of a scholarship will not usually exceed six months

(*c*) Ten Vacation Scholarships for students of mining and metallurgy at universities and approved schools of mines and metallurgy within the Commonwealth and Empire, to enable them to travel by air to important mining and metallurgical centres for vacation work The value of a scholarship will be up to £200 to cover the cost of air travel

The scheme has been drawn up in co-operation with the Institution of Mining and Metallurgy, which Institution will continue to assist the Foundation in the operation of the scheme

Forms of application for scholarships may be obtained from the Secretary, Nuffield Foundation, 12/13, Mecklenburgh Square, London, W.C. 1

ANNOUNCEMENTS

DR C C DAS GUPTA, M A , Ph D (Cal), Sir Rashbehary Ghosh Travelling Fellow, Calcutta University has just been admitted to the Ph D degree of the Cambridge University, where he worked in Numismatics under Prof Bailey Dr Das Gupta had previously worked on "The origin and Evolution of Indian Clay-Sculpture" and published a book entitled "Bibliography of Ancient Indian Terracotta Figurines"

Dr B S Chauhan, M Sc , Ph D , F Z.S , of the Zoological Survey of India has been elected a member of the American Society of Parasitologists Dr Chauhan is a specialist in Helminthology, with special reference to the parasites of Indian Food Fishes

SCIENCE IN INDUSTRY

MAGNETIC TAPE FOR SOUND RECORDING

THE simultaneous development in Germany and the U. S. A., during the war, of a new and simple type of magnetic tape for recording voice is reported in the *Science News Letter*, August 3, 1946. The magnetic tape consists of a paper strip coated with iron oxide and is quarter-inch wide.

The tape works in much the same way as the magnetic wire. The human voice received on the microphone is first converted into electric pulses which vary in tune with the sound vibrations and produce equivalent vibrations in the magnetic field of the machine. These vibrations are recorded on the moving tape. In the reverse process of reproducing the sound from the tape, the magnetic patterns are reconverted into electric currents to be converted into sound through the machine's amplifier and speaker.

During the process of operation, the tape often breaks, the broken ends, however, can be easily pasted together and the tape used as before. This is a great advantage over the magnetic wire which is almost as fine as a human hair and, once broken, is difficult to thread back into position.

The correct recording and reproduction considerably depends on the rate at which the tape is allowed to pass through the recording-reproducing mechanism. Faster the movement of the tape, more natural does the reproduction of the voice become. It has been found that the performance of the machine is as good as a radio with a 10 inch speaker when the tape passes through the recording-reproducing arrangement at the rate of 8 inches per second. The method is reported to be cheap.

NATURALLY TINTED FIBRES IN SOVIET RUSSIA

According to a report in the *Science News Letter*, August 31, 1946, experiments have been recently conducted in Soviet Russia to produce naturally tinted cotton fibres of brown, red and green colour. The naturally coloured fibres have greater resistance to decay and retain their tint for a longer period than do the artificially dyed white varieties. Accordingly, fabrics manufactured from the naturally coloured fibres are more durable and fade less than those made of artificially dyed fibres.

In a number of cases the chemical nature of naturally coloured cotton was established. The brown colour of the fibres is caused by a special organic substance of tannin type, the so-called catechol. On contact with oxygen in the air the tanning matter is oxidized and forms brown and red amorphous substances which give colour to fibre.

Coloured fibres have particularly high wax content. According to data of the Moscow Textile Institute, in green fibred cotton plants this equals 7 per cent to 10 per cent and in white fibred species 0.7 per cent. The presence of tanning matter and fatty wax substances in fibres gives greater resistance against decay.

The selection of cotton plants with naturally coloured fibres was begun in the U.S.S.R. with the study of such species met with in nature. From among a valuable collection of cotton plants, a fairly large number of species with coloured fibres were chosen. These varied from cream, through all shades of brown, to almost black and included reddish and greenish tints.

Tests proved that in the majority of cases these fibres were short and coarse, and that crop yield was low. Plant breeders were confronted with the task of improving technological properties of naturally-coloured fibres. In recent years considerable successes have been achieved in this direction.

By crossing American cotton plants with naturally coloured fibres and white fibre plant of the same type, B. Straumal of All-Union Cotton Cultivation Research Institute succeeded in a comparatively short time in obtaining a number of brown-hued staples of excellent technological properties, closely approaching those of the best white-fibred varieties. Scientist Straumal's varieties ripen early and yield fairly good crops. The length of staple is 30 millimeters (1/8 inch), yield after ginning up to 35 per cent and tensile strength six to seven grains.

A valuable property of these cotton plants is their good resistance to wilt, and these varieties are being propagated for cultivation in fields. Tests of the Straumal varieties showed that catechol, when reinforced by salts of iron, copper and chromium, gives colour to fabrics in no way inferior to the best artificial dyes. Catechol makes it possible to vary shades and gives good decay-resisting properties to fibre. According to specialists, this fibre can be used without additional dyeing for manufacture of coloured fabrics.

Of exceptional interest is the work carried out by I. Maximenko, selectionist of Turkmenian Soviet Republic, on species of cotton plants with green fibres. As a result of crossing cotton plants of pur-

purescence type with American and American with Egyptian species, and of further careful selection of their offspring with differently coloured staples, Maximenko succeeded in obtaining absolutely new shades hitherto unknown in nature According to Maximenko's research, the green colour of cotton fibre is not chlorophyl and differs in nature from brown colouring. This is indicated by the manner in which the colours appear Whereas brown, according to Maximenko's observations, appears within 20 to 25 days of beginning of formation of ball, green appears within 30 or 40 days It was also established that the green colouring changes easily under influence of external factors For instance, given surplus moisture, green will become almost black and, on the contrary, with insufficient moisture it becomes lighter

Outstanding shortcomings inherent to green fibre cotton plants are their low crop yield and weakness of fibre. These were successfully overcome by Maximenko Varieties which he selected from hybrids are already yielding fibre with a higher tensile strength

COTTON SUBSTITUTE

Sphagnum moss suitably prepared is a good substitute for raw cotton and lignin For dressing wounds it has definite superiority over other substitutes It is soft, elastic, and non-irritating, This is due to its structure, 50 per cent of which consists of large, empty or vacuolated cells, which enable the moss to absorb 10-25 times its weight of water The dried moss not only absorbs water or moisture readily, but also takes up pus. For this reason it is being employed for bandaging wounds. A chemical examination of the material showed the presence of a phenolic constituent with weakly acid properties, which is known as *shagnolin* It also possesses mild antiseptic properties This investigation on the properties of *Sphagnum* moss have been carried out at the Research and Control Laboratory of the Pharmacy Poard of Bashkir Province (U S S R) (*Farmatsiya*, No 3, 1944)

Infusions of *Sphagnum* were prepared with hot and cold water respectively, and studies were made on the water content of the native moss, on the absorptive potency of the moss, the hydrogen-ion concentration of the infusions, and some of the properties of the ether extracts of the moss It was found that the acidity of the infusions made with hot water is greater than those made with cold water On sterilizing *Sphagnum* in the autoclave, infusions made from sterilized material are also more acid than those made from unsterilized moss This is of surgical interest, as the acidity may contribute to the antiseptic properties of the product

Sphagnum grows wild in the Sikkim Himalayas, Khasia Hills and various other places in India A survey of the moss and the possibility of utilizing the same in surgical dressings etc needs investigation by the Botanical Survey and the Council of Scientific and Industrial Research, in India

MANUFACTURE OF ELECTRICAL MEASURING INSTRUMENTS IN INDIA

B B BHOWMIK

THE electrical measuring instruments are by far the most important group of general scientific instruments In addition to their need for teaching and research they are essential for electrical development and its utilization For post-war development of electrical power in the country they will be required in very large number, and shortage of instruments will definitely handicap any such project So it is advisable that the Government should encourage establishment of this industry in the country in every possible way.

In these notes consideration is given to measuring instruments required for general electrical work Laboratory Instruments like post office box, meter bridge, tangent galvano-meter, D'Arsonval galvanometer, ballistic galvanometer etc., as well as very special type instruments like maximum demand meter, are not being considered

Ammeters, voltmeter, wattmeters, watt hour meters, (house service meters), insulation measuring meters—meggar, ohmmeter, power factory meters, frequency meters, electrical pyrometers,—are some of the common electrical measuring instruments of which ammeters and voltmeters are the most widely used instruments. A firm that can manufacture different types of ammeters and voltmeters can easily take up manufacture of other electrical measuring instruments mentioned above. In the manufacture of ammeters and voltmeters, the principles of different physical phenomena are taken help of, and consequently there are different types of ammeters and voltmeters, such as moving iron, moving coil, electro-dynamic, hot wire and thermo-couple types.

History of Manufacture in India

Before the World War II, it is doubtful if any electrical measuring instruments named above were made in India or even any serious attempt was made in this direction. In this side of India (Calcutta), instruments, both commercial and highly delicate ones, were being successfully repaired and standardized at the Applied Physics Laboratory, University College of Science, and also at the Laboratory of the Chief Electrical Advisor, Government of Bengal. After the outbreak of the war when the import position was getting seriously affected, several parties planned and manufactured ammeters and voltmeters. Government Telegraph Workshop, Alipore, made a few moving iron type meters (perhaps the first moving iron type meters made in India). The accuracy obtained was quite good, error lying within 2½ per cent. After making only a few of them for their own use, they discontinued it.

Round about the same time, Jay Engineering Works Ltd., Calcutta is said to have exhibited two such moving iron type meters (of their own make), switch board pattern in an exhibition, and it transpired that they had taken up this line also. Since then nothing much is heard of them, neither any advertisement nor their products (ammeters and voltmeters) are seen in the market. But the firm is perhaps the only manufacturer in India of water meters which have earned high reputation from all quarters.

At about the same time Messrs. Radon House, Calcutta, undertook the work seriously and under the personal guidance of an engineer, trained abroad, assisted by several M.Sc's., the work progressed slowly but steadily. After two years of experiments they put into the market commercial grade moving iron meters. Thereafter they diverted their attention to moving coil meters and after several years of continuous experiment have succeeded to place in the market "moving coil meters",—ammeters, voltmeters, milliamp, milli-volt, micro-amp, and pointer galvanometers in different shapes and sizes up to "first-grade" (This is perhaps the first moving coil meter made in India). They have also succeeded in making hot wire and thermo-couple types of meters. "Radon House Meters" are approved by I.S.D. and are purchased in large quantities by the Supply Department, Government of India. The Supply Department's purchases are made by open competition and "Radon House Meters" are competing in price and quality with meters imported by Messrs. G. E. C., Balmer Lawrie, T. E. Thomson, etc. Other Government Departments including the Railways and also many teaching and research institutions are using meters made by Radon House.

Just a little while later, one Bombay firm—Messrs. Automatic Electric Device Co., came out with moving iron meters. Messrs. Marshall & Sons is said to have taken their selling agency. Their meters (A.E.D.C.) are known throughout the country and they are also approved by the Department of Supply. Instead of going into different varieties and types they are consolidating their position in moving iron meters in portable as well as in switch board patterns in several dial sizes. Their capacity of production is also quite good.

There is also another firm in Poona started by Mr. Athavle sometime ago. It is learnt that Messrs. Athavle have come into some financial arrangements with Messrs. Kaycee & Co., Ltd., the well-known electrical merchandizing firm. So far as the information goes, Messrs. Athavle were concerned with general scientific and laboratory instruments including optical and spectroscopic ones. But from recent advertisement of Kaycee & Co. Ltd., it appears that they are making voltmeters, pyrometers and galvanometers. One of their (M/s. Athavle's) men has gone to England for training in scientific instruments, and it is expected that this firm will bring out larger varieties of quality products.

The production capacity of the firms named above is quite good. With proper encouragement and possible advent of one or two more firms they would be able to meet the country's entire requirement of commercial second and first grade ammeters and voltmeters including milli-amp., milli-volt and micro-amp meters. It can reasonably be expected that they would also start producing substandard meters also. If the object be to manufacture all varieties of measuring instruments enumerated before, the present capacities of the firms will have to be considerably increased, or a few more firms should be encouraged to take up this line, each specializing in one or two varieties.

Raw Materials—General and Special

The general raw materials needed for the manufacture of instruments are M.S. and brass rods, sheets, pipes; aluminium sheets, pipes and cast iron materials; and as these are available in India it is needless to go into their details. The special materials listed below should receive due consideration.

(1) *Jewelled Bearings.*—Almost all indicating and integrating instruments require jewelled bearings and they are of fundamental importance in measuring instrument industry. The jewelled bearings used to be made generally from natural sapphire, ruby, agate and garnet. A very scrutinizing and proper selection of stones is necessary before making jewelled bearings out of them. Presence of impurity and non-

homogeneity is likely to cause failure. Even when a proper selection is made, bearing-making is a very difficult and skilled art. Some up-country diamond cutters have developed this skill. Though most of the meters so far manufactured in India by firms mentioned in this paper used indigenous jewelled bearings, yet for want of prolonged encouragement and for lack of scientific knowledge and proper machinery, the quality of the product (jewelled bearing) is very poor. These bearings may be suitable for commercial and second grade instruments but they are unsuitable for high grade --sub-standard and standard instruments. In advanced countries in these days all jewelled bearings are made from synthetic sapphire. England before this war was not manufacturing jewelled bearings. These were imported into England from Switzerland. Being a subsidiary industry to watch making, Switzerland is one of the best jewel-making countries.

Just for want of these tiny articles of jewelled bearings England was in a very difficult situation. All her bombers and fighters would have come to a stand-still but for jewelled bearings in their meters. In the thick of the war amidst great peril, they managed to send one or two experts to Switzerland. They offered to purchase the processes, but legal objection of the country stood in their way. They were ultimately given the secrets and technique of jewel-making on condition that Switzerland's watch-making industry and post-war situation would be guaranteed. Thereafter these experts managed to get back to England with some vital parts of machinery for manufacture of synthetic sapphire and jewelled bearing. These machinery were copied in large numbers, and the industry was established which helped her out of a very difficult defence situation. Number of jewelled bearings utilized during the war often exceeded 50,000 a week. It has now been set on a sound footing and the industry has become a very paying one as in addition to manufacture of synthetic sapphire for jewelled bearings they are making artificial jewels for ornaments.

If India has to make high grade measuring instruments, either the jewelled bearings have to be imported, or they are to be manufactured here under expert supervision. Being so small in their sizes they are likely to be overlooked but the facts narrated above will amply prove how important the item is. So it is suggested that the Government of India should take special interest in the matter and in the proposed Glass and Ceramic Research Institute, there should be a competent department to make jewelled bearings themselves or to help in establishing this industry on sound footing through semi-Government or private concern.

(2) *Hair Springs—Phosphor Bronze.*—Next in importance to jewelled bearing is the hair spring. They should have high elastic property, uniform thickness and breadth throughout the length of flat wire and also the helical coils should be uniformly spread out and the spring as a whole should be small and have a requisite tension which should remain permanent and must not alter with time and use.

During this war, phosphor bronze hair springs became very scarce so much so that it was not available in the market. Many important works on electric meters, not only civil but military work as well, were held up for want of this article. This work was undertaken in the laboratory of Messrs. Radon House. Material of proper size was not available. Thicker gauge phosphor bronze wire was purchased and was drawn into very thin gauge, say over S.W.G. 40. Then it was cold-rolled into flat tape by means of Goldsmith's roller and finally the spring was wound by slow hand process. The hair-springs thus made stood rigorous tests of Air-Force authorities who took quite a large supplies of this indigenous componet for very important defence work.

It is surmised that most of the meters now being manufactured in India are using indigenous hair springs thus manufactured by hand process. Though they rendered admirable service in time of emergency, it is time now that the industry should be set on sound basis. Some Government sponsored research institutes should undertake the work or the Government should induce and help a private laboratory to undertake the work. On further investigation it has been noticed that springs manufactured from phosphor bronze wire available from local market, compares favourably with imported hair springs in mechanical properties, the electrical resistance of the indigenous one is much higher than the imported ones. Very recent information received says that imported hair springs for meters are made from a beryllium alloy wire. Besides this metallurgical aspect their method of large scale production and proper tempering is highly technical and somewhat secret. Without a State help, a private concern is not likely to take up manufacture of this component which is indispensible for manufacture and repair of indicating instruments vital for defence and peace time development. It may be pointed out that before this war hair springs were not manufactured in England. She had to face great difficulty in introducing this industry during the war.

(3) *Pivot Wire.*—The pivot is made from hard steel wire generally of gauge Nos SWG 21, or 22 cut to requisite length. The ends are made to highly polished cone-shaped points, and are sometimes hardened before being polished, to withstand wearing and getting blunt. Imported pivot wires in different gauge sizes are obtained in large quantities

in watch-maker's shop During the war, even when all imported articles and components became very scarce, pivot wires were obtainable in the market The imported pivot wires are obtained in very straight form and they have a blue coating which prevents easy formation of rusts Hard steel wire available in local market when well polished serves the purpose equally well Making of pivot ends, hardening and final polishing so that it may not be too sharp or too blunt, is a skilled art

(4) *Magnetic Material.*—(*a*) In moving iron meter the fixed iron pole and the moving iron pole, two small strips are made of soft iron sheet This iron should have high permeability and minimum coercivity , it should have also minimum hysteresis and eddy current loss In the absence of Swedish soft iron sheet and ferro-nickel alloy sheet, transformer sheet of silicon alloy may serve the purpose

It should be mentioned here that the Board of Scientific and Industrial Research has shown great interest in the development of measuring instruments and has sanctioned a research grant to a university laboratory for development of moving iron meters

(*b*) Permanent magnet forms an essential material for moving coil instruments and also for various other scientific instruments, and electrical equipments It is very unfortunate that this material was not produced in the country until recently The Board of Scientific and Industrial Research realized its importance and sanctioned munificent grant to Messrs Tata Iron and Steel Co , Ltd , who have started manufacture of this material They have produced several types of alloys such as chromium-carbon, tungsten, cobalt-molybdenum and 'Alni' types They are reported to be quite satisfactory for manufacture of permanent magnet It is highly commendable that the Board of Scientific and Industrial Research has also sanctioned another research grant to study the manufacture of permanent magnet suitable for electrical instruments (with reference to shape, size, pole gap, magnetic field, etc.).

The types of alloys so far made in India are reported to be quite good for general purpose and magnets made of these alloys should be quite suitable for measuring instruments , but with rapid development in the line, use of these alloys in measuring instruments (magnets) has become out of date in advanced countries For very high grade measuring instruments and if the object be also to make very small and light measuring instruments such as multi-range meters and air craft instruments, latest types of magnetic materials such as Alnico, Alnico I, Alnico II, Alnico III and alloys containing vanadium should be manufactured in India. The Government should request Messrs Tata Iron and Steel Co., Ltd., to take up the manufacture of these materials (alloys) as well

(5) *Instrument Wire: Winding and Resistance.*—D C C copper wires up to SWG 40 are being manufactured in India For instruments, specially moving coil instruments, insulated copper wire either enamelled or D S C of very thin gauge, say up to S.W.G. 50, is required. 'Manganin' strips and insulated wires including thin gauge, say up to SWG 50, are the best for shunt and multiplier resistance on account of their least resistance co-efficient Best quality manganin wires are not still manufactured in Egland on commercial scale. In the absence of manganin, eureka wire may be used as substitute and unless the design is also modified use of the substitute will impair the declared accuracy of the meters Until these instrument wires (specially the fine gauge ones) are manufactured in India, a steady import of these materials should be assured It is a matter of great satisfaction that the Board of Scientific and Industrial Research has also financed a research scheme on the manufacture of resistance wire and the work is in progress

Platinum iridium wires for thermo-couple instruments and platinum-iridium and platino-silver wires for hot wire instruments are necessary which have to be imported for high grade meters But in the first case, iron and constantan wires may serve as substitutes and in the second case nichrome wires will serve as substitutes for ordinary grade meters

Machinery and Equipment

No heavy machineries of any special type are necessary for manufacture of electrical measuring instruments Light but precision type screw-cutting and surfacing lathes, drilling machines, punching and drawing presses are the principle machineries required. Small capstan lathes will help production work of stereotyped parts Shaping and grinding machines as well as heat treatment furnace are necessary, if permanent magnets for moving coil instruments are also to be manufactured Die casting and bakelite moulding equipment may be added for better class products Goldsmith rolling machine and small weighing balance may be added to the above list. For manufacture of components like drilling of jewelled bearings and winding of hair springs, special machinery have to be imported, whose costs are moderate. For manufacture of watt-hour meters and other integrating instruments which incorporate clock work and gear train, complicated machinery for gear cutting and pinion making would be necessary.

Skilled Workers and Technical Personnel

Shortage of skilled labour in the country is the greatest drawback in the development of all industries, not to speak of instrument industry only. The matter was discussed in the Applied Physics Committee meeting under the B S I R held at Bombay in August, 1945, and necessary recommendation was made to the Government, which need not be repeated here.

Great skill and delicate manual operations are required in final assembly and fitting of measuring instruments. Skilled workers in this line are very few, and this difficulty may be overcome by recruiting apprentices and workers from watch-making (repairing) shops and giving them six months to one year's training under expert supervision. As to higher technical personnel science graduates and M Sc s in Physics, Applied Physics and Electrical Engineering after undergoing about one or two years' training in the line should be capable of undertaking expert supervision and solve incidental problems met in course of manufacture and design work. Inspite of this fact Government of India should send a few (at least one or two) students abroad to study general technique and latest methods of manufacturing processes and the Government should also start a few polytechnics for training of skilled workers so that a large number of technicians will be available for the industry. It is very unfortunate to observe that among the workers in this country, when one is given any special training and he acquires a particular skill, he becomes very reluctant to teach his fellow workers and diffuse the knowledge amongst them. It is possible that this mentality develops as a safeguard against his insecurity and losing hold over his fellow workers, and repeated assurances from the authorities (managing staff) hardly change his mentality.

Testing and Standardizing Institutes

The private firms manufacturing electrical measuring instruments should possess master instruments of standard reference for calibration and checking of their products. Not only they should have master instruments, but these instruments should be periodically checked by a State Department possessing necessary equipment and personnel like the proposed National Physical Laboratory or Government Test House, Alipore, whose instrument department should be further developed for this type of work. Such a State Laboratory should be the final authority in testing indigenous products and issuing certificates to the manufacturing concerns. They should occasionally make comparative tests on indigenous and imported instruments of some declared 'grade', and issue communique of the results to the public who will gain confidence on indigenous instruments.

There should also be established an *Institute of Standards** who should formulate specifications best suitable for the Indian conditions. Many standard specifications meant for the United Kingdom is not at all suitable for Indian condition, to quote one example—B S specification 171 for transformer allows 50°C rise of temperature above room temperature which is quite unworkable in India. Current and potential transformers are part of instrument industry.

State Help

Even if all the recommendations made here are fulfilled and general circumstances become favourable, it is doubtful if this infant industry can survive without the State help. The State should generously encourage this industry because of its importance in defence services and peace time development.

Firstly, the Government should see that at least a certain percentage of their total requirements of measuring instruments is purchased from the indigenous manufacturers.

Secondly, the Government should give proper safeguard to indigenous manufacture against big combines of foreign manufacturers.

Thirdly, the Government should undertake research work in their laboratories and encourage research schemes for solution of problems likely to arise in course of manufacture and development. This subject has been dealt with in the component section and it is gratifying to note that they have already taken action in this direction. Starting of a few polytechnics for training of technician has also been mentioned in the previous section.

Fourthly, special consideration should be given to indigenous manufacture for supply of raw materials during the continuance of existing 'Controls' and issuing of import licence for some components to encourage manufacture of high grade instruments in the country.

Lastly, as considerable amount of delicate manual labour is required in the manufacturing process and also as the articles as a whole or the components are very light and small, the Government should explore the possibility of introducing this trade or some parts of it (manufacture of components) on cottage industry basis.

*** The Government of India have recently decided to set up an organization called the Indian Standards Institution with headquarters in New Delhi.—Ed** ***Sci & Cul.***

MEDICINE AND PUBLIC HEALTH

ADVANCES IN MALARIAL RESEARCH

A number of significant advances in the study of malaria is reported in a report of the Board for the Co-ordination of Malarial Studies, U S A Studies on immunity in the avian infections have given information on the cross immunization obtained with different species of parasites

A great number of chemical compounds have been investigated for antimalarial activity in various avian infections and in human malaria Among the practical advances resulting from these studies may be mentioned 1 The development of better methods for the use of quinacrine (atabrine) in the suppression and treatment of malaria, which led to the demonstration that this compound is superior to quinine 2 Development of compounds superior to quinacrine Among these are several members of the 4-amino-quinoline series In this group SN7618, 7-chloro-4-(4-diethylamino-1-methylbutylamino) quinoline, has received the most extensive study, both in civilian and military establishments. The compound is an effective suppressive when administered no more frequently than once a week in a well-tolerated dose It will also cause an abrupt termination of the clinical attack of vivax malaria and will cure falciparum malaria when administered for only one or two days It does not discolour the skin, as does quinacrine, nor does it give the disagreeable gastro-intestinal symptoms which are sometimes seen with the administration of quinacrine. 3 The field of investigation of suppressive drugs has been extended, the major emphasis being focussed on the study of the 8-amino-quinolines with the hope of discovering a non-toxic curative agent This line of investigation received impetus from British investigation of pamaquin (plasmochin) in vivax malaria. Curative action of pamaquin was demonstrated in vivax malaria due to both domestic and south-west Pacific strains of *P vivax* (*Science*, January 4, 1946)

STREPTOMYCIN AND PROMIN IN TUBERCULOSIS

Guinea pigs infected with tuberculosis were employed by Smith and McClosky to determine whether streptomycin has any beneficial effect, to compare the results of streptomycin therapy with the sulphone promin and to explore the possibilities of combined treatment with these two chemotherapeutic agents Under the experimental conditions of treatment streptomycin injected intramuscularly produced a definitely greater chemotherapeutic effect than promin The dose of promin used was about one-half the maximum tolerated dose, while the dose of streptomycin used was less than one-twentieth of its maximum tolerated dose , hence streptomycin had a therapeutic index at least ten times that of promin Neither of these agents used alone completely eradicated the tuberculous process Larger doses and better methods of administration may well increase the therapeutic effect of streptomycin. By the application of a suitable combination of promin and streptomycin, Smith and McClosky obtained results better than any they had ever achieved before in the treatment of experimental tuberculosis infections. They believe their experimental results warrant the cautious application of combined treatment to selected patients (*Journal of the American Medical Association, XXIX*, p 620, 1945)

REQUIREMENTS OF THE NORMAL DIET OF DIFFERENT AGE AND SEX GROUPS

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(*Continued from the last issue*)

Composition of the Diet

THE question now arises as to how much of each of these articles of food is to be included in the adult diet, so that the normal requirements are satisfied.

The first task in this respect is to have a supply of 60 g protein, at least ⅓rd of which is to be derived from animal sources, *i e*, from fish, meat, or poultry and milk The importance of milk has been already stressed Accordingly a minimum of milk is essential Milk Ca is most readily available to the body As Ca requirement of the body is of pressing importance, it is considered safe to have at least ⅓rd of the total daily Ca requirement of the body (which is 0 88 g) from milk which contains about 0 12 per cent Ca This is available from about 9 oz milk Thus 8 to 10 ozs of milk are recommended for adult persons by the Nutrition Advisory Committee under the I R F A (Indian Research Fund Association) If milk is diminished, other sources of Ca, such as vegetables, particularly leafy vegetables (spinach is a bad source of Ca as it contains oxalates), bones of small fishes (lime taken with betel leaves is also available to some extent) etc, are to be provided for in the diet to a greater extent As there is shortage of milk and its price high, its amount is required to be reduced further, say, to 6 oz Now 6 oz of pure milk supplies nearly 5 6 g protein The remaining 14 4 g animal protein is available from a little over 2 5 oz of meat or fish As a little surplus is also desirable, 3 oz of meat or fish is therefore recommended as our daily requirement by the Nutrition Advisory Committee and also in the Pattern Dietary scales worked out by the Medical Research Council for the Far East Now 3 oz meat or fish would provide about 18 g protein The remaining protein requirement, *i e*, $60-(5\,6+18)$ *i e.*, 36·4 g) is to be obtained mainly from cereals and pulses Rice, which is most widely used in Bengal, has a low protein value (6·4 per cent in parboiled milled rice) and is poor in vitamin B_1, whereas pulse has a high protein content (20 per cent on the average) and is rich in vitamin B_1 Again rice and pulse form supplementary relations* both as regards maintenance and growth It is for these reasons rice should always be taken with pulse If half of the remaining protein requirement, *i e*, $\frac{36{\cdot}4}{2}$ *i e*, 18·2 g is obtained from pulse, the consumption of rice may be much diminished for the supply of the major part of the still remaining protein need. 3 oz pulse would furnish about 18 g protein and accordingly this is recommended for the daily intake The consumption of rice may be diminished with advantage for the following reasons

(*a*) When rice is boiled, it is swollen up with 5 to 6 times its volume of water Consequently large intake of rice will over-distend the stomach and thus cause distress and laziness, (*b*) Carbohydrate rich foods, as rice is, are more subject to fermentative changes in the intestine with the production of gases and discomfort and lead to the formation of faeces of highly acidic reaction Before the amount of rice required is calculated, it is essential that the supply of vitamins and minerals is ensured and provision be made for the normal 'scrubbing' of the alimentary canal and regular movement of bowels without which a man cannot have the cheer and smile of good health To provide for all these particulars, the Nutrition Advisory Committee recommended 4 oz leafy vegetables, 3 oz. other vegetables, 2 oz fruits It is also suggested that 3 oz potatoes or sweet-potatoes are added to the diet to make the food palatable and to supply some available carbohydrate in order that the consumption of rice may be diminished The various foods so far recommended would provide the following amounts of proteins, fats, and carbohydrates, besides satisfying

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* Two proteins are said to form supplementary relations when the biological value (B.V) of the mixture of two proteins is greater than the computed B.V, either as regards maintenance of the adult or growth of the young Thus milk (B V -85) and white flour (B V —52) mixed in the ratio of 1 to 2 give a B V of 71, although the computed value is $\frac{85+2\times52}{3}=\frac{85+104}{3}=\frac{189}{3}=63$, similarly white flour and beef (B V —69) mixed in the ratio of 2 1 give a B V of 73, although the computed value is $\frac{52\times2+69}{3}=\frac{173}{3}=58$ nearly Again zein (corn protein) cannot support either growth or maintenance Lact-albumin at a level of intake less than 9% cannot support normal growth Yet normal growth occurs on a diet containing 13 5% zein and 4 5% lact-albumin Thus zein and lact-albumin form supplementary relations

nearly the total adult requirements of vitamins and minerals

	Proteins in g	Carbo-hydrates in g	Fats in g
(Pure)* Milk—6 oz	5 6	8·1	6 1
Fish or Meat - 3 oz	18 0	—	Variable (depending on the quality of fish or meat, small fish or lean meat supplying little fat)
Pulse—3 oz	18 0	51 0	—
Potato or sweet potato—3 oz	1 5 to 1 7	17 to 25 5	—
Leafy vegetables, Other vegetables, Fruits	5 to 6	20 to 30	—
	48 to 49	96 to 114	above 6 1

The total requirements of proteins, fats and carbohydrates being 60 g, 69 g and 410 g respectively, the remaining 12 g protein may be obtained from 200 g (−7 oz.) of parboiled, milled rice which would supply about 158 g carbohydrate The unsatisfied needs of carbohydrate and fat are to be obtained from more than 5 ozs of sugar and jaggery and 2 ozs of fat (natural or vitaminized and hydrogenated) But such a large amount of sugar or jaggery is not conducive to good health and the average Bengalee is too poor to have *per capita* consumption of 3 ozs meat or fish It is, therefore, proposed to reduce the requirement of fish or meat to 2 ozs. daily In that case the deficit of protein to be made up would be about 18 g which would be obtained from about 300 g (−10 5 oz.) of parboiled, milled rice supplying about 237 g carbohydrate The remaining carbohydrate requirement may be obtained from 2½ oz sugar and jaggery

If 85 per cent extraction flour† is used instead of rice, then the deficiency of 18 g protein may be made up by the intake of 215 g, but as the biological value of proteins of flour is much less than that of rice proteins, it would be safe to take 300 g flour instead of 215 g This would supply about 150 g carbohydrate Therefore the remaining carbohydrate requirement will have to be met from about 6 oz of jaggery and sugar which is neither conducive to good health nor can be tolerated It would, therefore, be necessary to have the carbohydrate requirement met partly from rice and partly from flour, thus reducing the necessity of the intake of a large amount of sugar.

* Pure milk is scarcely available in Calcutta

† 85 per cent extraction flour has the following composition—100g contains protein—8 4g, carbohydrate—48g, fat—1 3g, Fe—2 to 3 mg, Thiamine—62 I U., Ca—40 mg (20 mg unavailable, etc.).

Thus the total daily requirement of an average adult Bengalee doing light work would be as following

Fish or meat	2 oz	
Rice	10 5 to 11 oz	(*i e*, 5½ *chataks* nearly)*
Pulse	3 oz	
Milk or whole milk products	6 oz	
Potato or sweet potato	3 oz	
Leafy vegetables	4 oz	
Other vegetables	3 oz	
Fruits	2 oz	(It is advisable to include citrus fruits daily)
Sugar and jaggery	2½ oz	
Fats & oils	2 oz	

REQUIREMENTS OF FOOD OF DIFFERENT AGE-GROUPS

In discussing these requirements, particularly in the case of infants, boys and girls, the following considerations are of paramount importance

(*i*) Variations in the basal metabolism per sq metre of body surface and

(*ii*) Rate of increase in body-weight of children

As there are no accurate observations on those two important questions in this country, we shall have to depend on data of other countries According to M S Rose, the basal metabolism, after birth up to 2 weeks, varies between 25 to 30 C per hr per sq m (adult male—40 C per hr per sq m), at 3 months 39 C, then increases steadily up to 48 C at 21 months, remains constant at about that level upto 3 years and then gradually declines to the adult figure at 11 years It further declines slightly upto 14 years and then increases quickly to a maximum of 45 at 15 years and then declines gradually to the normal level at about 19 years The basal metabolism again begins to decline at an advanced age, particularly after 60 years †

The basal metabolic rate (B M R.) in girls is slightly lower than that of boys of corresponding ages There is no proof of the influence of pre-pubescence on B M R, nor there is any definite proof of the increase in B M R. at the onset of puberty, but there is a tendency to a pre-menstrual

* If rice be replaced wholly by 85 per cent extraction flour, then sugar and jaggery are to be increased to 6 oz But as this is not desirable, the remaining requirement of carbohydrate is to be met from tapioca, or pulses or potatoes If rice is partially replaced by 85 per cent extraction flour then also sugar and jaggery are to be increased according to the degree of replacement If ground nuts or cashew nuts are taken, then the amount of pulse and fat should be reduced by calculating from the percentage composition of pulses and nuts given before

† According to Murlin the B M R gradually declines after the age of 40, the rate of regression being of the order of 0 664C per sq m, per hr in each succeeding decade Accordingly the food requirements are to be reduced at the same rate.

rise with a subsequent fall during menstruation in some girls and in the inter-menstrual period in others. The B. M. R during pregnancy rises steadily from the fourth month and becomes 25 per cent higher just before delivery It is curious that an increase in B M R. during lactation could not be proved definitely.

The relative daily gain in body-weight of children is, according to Mendel, 1 per cent in the 1st month, 0 3 per cent at the 6th month, 0 15 per cent at the end of the 1st year, 0 03 per cent at the 5th year and in later years 0 07 per cent for boys (maximum) and 0 04 per cent for girls (maximum)

After considering the B M R and the rate of growth at different ages, the British Medical Association express the caloric requirements of different sexes and ages in terms of the average man, taken as 1, as follows·

	Man value	Calories required in the case of Bengalees
Adult male	1 00	2500
,, female	0 83	2075
Child (bet 1 & 2 years)	0 30 to 0 35	750 to 875
,, (2 to 3 yrs)	0 40	1000
,, (3 to 6 yrs)	0 50	1250
,, (6 to 8 yrs)	0 60	1500
,, (8 to 10 yrs)	0 70	1750
,, (10 to 12 yrs)	0 80	2000
,, (12 to 14 yrs)	0 90	2250

In determining the caloric requirements of Bengalee boys the man values of boys of different ages, as adopted by B M A have been accepted in the absence of accurate observations in our country As it is not unreasonable to consider that the ratio of the rate of growth at any age to the maximum growth attained cannot but be more or less the same under normal conditions in any country, it follows that the man values of boys, as adopted by B M A would also be the same in all countries *Accordingly the caloric requirements of boys of different ages, as given in P. 20 of the Health Bulletin No 23, published in 1941, by the Government of India, cannot be accepted*

The caloric requirements of girls of different ages would be slightly lower than that of boys.

In growing children it is usual to think that as there is retention of N in the body, the protein requirement per kg. of body-weight should be higher than that of adults As we may consider mother's milk to be the ideal food for the growing child, its relative protein content gives an indication of the protein requirement during active growth. Human milk contains 1·4 per cent protein, 3·7 to 3·9 per cent fat and 7 per cent carbohydrate Accordingly 100 g of human milk supplies nearly 68 C, 8 to 9 per cent of which is obtained from protein Human milk proteins are of very high biological value It is thus evident that if nearly 10 per cent of the caloric requirement is obtained from protein of very high biological value, active growth is supported, provided, of course, the total caloric requirement is satisfied from fat and carbohydrates With the growth of the child, mother's milk becomes insufficient to meet the growing caloric needs. Hence weaning becomes necessary During weaning and for sometime afterwards, the main feature of the child's diet should be cow's milk* which furnishes about 19 per cent of its calories in the form of protein Thus actively growing children, when put upon an artificial diet, require, in proportion to their weight, a greater allowance of protein than adults It is usual to have 19 to 16 per cent of the total caloric requirement furnished by protein up to one year The protein requirement falls gradually to the 6th year when it amounts to about 13 per cent of the total caloric requirement. This value should be maintained up to the end of the period of growth The requirements of proteins of high biological value are also greater in growing children than in adults In young infants upto about 1 year good quality proteins (as in milk) should constitute about 100 per cent of the protein allowance , at one year over 90 per cent, and up to 5 years over 60 per cent, from the latter age to adolescence the proportion should not be far from 50 per cent and in adult life at least 33 per cent Sherman recommends the following distribution of calories in diets of children of 4 to 12 years

PERCENT OF TOTAL CALORIES FROM EACH CLASS OF FOOD

Age in years	Foods from cereal grains	Milk	Proteins etc vegetables & fruits	Fats	Sugars & sweets	Eggs, meat, fish etc
4—5	23 25	45 -50	14—18	5 - 8	2—5	5—6
5 —6	23—25	45—50	14 -18	5 - 8	2—5	5—6
6—7	20—25	40—45	14—15	10—12	3—4	4—5
8—9	20- 25	38—42	15—16	12—13	4—6	5—6
10—12	20—25	34—38	17—18	13—14	6—8	7—8

REQUIREMENTS DURING PREGNANCY AND LACTATION

Requirements during pregnancy would be evident from the following considerations·

(i) "With generous amounts of proteins in the diet, the maternal organism tends to store N_2 greatly

* The proteins of cow's milk are inferior to those of human milk in biological value and hence the necessity of a greater allowance of protein after weaning.

in excess of the requirements of the foetus and its adnexa and that this maternal reserve acts to offset the strongly negative nitrogen balances of the subsequent lactation period "

(ii) The amounts of material actually transferred into the body of the foetus have naturally a bearing upon the nutritional demands of pregnancy The body of a baby weighs about 7 lbs at birth and contains roughly 500 g protein, 24 g Ca, 14 g P and 0 4 g Fe, over 2/3rd of this is laid down in the last 3 months and 1/3rd in the last month of pregnancy

(iii) The materials contained in the body of the baby at birth do not represent the whole of the increased need of pregnancy over simple maintenance, for the mother lays down new protein in the growing uterus, breasts and other tissues Balance experiments show that these layings and nutritional reserves stored in the maternal body during this period to offset the heavy demands of lactation after delivery, amount to about 500 g protein besides about 10 to 15 g Ca and about 50 g P

(iv) It has been mentioned before that the basal metabolism begins to rise from about the 4th month of pregnancy and increases by 25 per cent at the end of pregnancy.

The demands of pregnancy could be met by a daily intake of 1 5 g protein per Kg of body-weight and 1 5 g Ca in addition to increased intake of various vitamins, particularly vitamins A and D Mellanby's recommendations for a diet during pregnancy are Milk 1 to 2 pints (20 fluid ounces—1 pint), green vegetables and one egg, fish, liver (once weekly) and codliver oil 1 to 2 oz daily, besides other foods to meet the caloric needs.

The lactating mother requires food not only for her own needs of maintenance and growth (in the case of young mothers) but also for supporting the active growth of her baby and its vigorous movements The requirements of the baby are to be computed from its caloric needs which are best satisfied by mother's milk The caloric needs depend (*a*) upon its basal metabolism (per sq. metre of body surface) an estimate of which, according to Rose, has been given before, the basal metabolism varying, of course, according to the daily gain in weight (*vide* Mendel's figures mentioned before, which reveal that a child doubles in weight in a little over 3 months, for the rate of daily gain is 1 per cent for about 6 months) and (*b*) upon the vigorous movements of body, which vary from child to child. It is not easy to ascertain the caloric needs for supporting the variable bodily movements of the child.

In Europe the daily caloric requirements of average normal infants of various ages are considered to be as follows

	Average caloric requirements of infants in Europe	Average caloric requirements of infants in Bengal	
1st week	250	225	
1st month	300	270	The caloric requirements of infants in our country are taken to be 10 per cent lower than European averages, as in the case of adults
2nd ,,	500	450	
3rd ,,	560	500	
5th ,,	750	675	
8th ,,	875	785	
12th ,,	1000	900	

Now 100 g of human milk supplies 68 C As milk has a specific gravity of 1028 to 1034, on calculation, it is found that 1 oz milk would supply nearly 20 C To supply the caloric requirements of the child, while it is growing, the yield of breast milk should be in the 1st week about 11 oz, in the 1st month about 14 oz, in the 2nd month about 22 oz, in the 3rd month 25 oz, in the 5th month about 34 oz, in the 8th month about 39 oz and in the 12th month about 45 oz The milk yield of a nursing woman in England begins with 2/3rd oz on the 1st day, increases quickly to 7 5 oz on the 3rd day, to 17 oz at the end of the week and then goes on rising upto 34 oz at the end of the 28th week after which it begins to decrease Under normal conditions, the secretion of milk lasts for six to nine months and may in rare cases extend over more than a year The yield of milk depends upon various factors, *viz*, hormonal,* nutritional and reflex caused by repeated suckling by the baby In India no work has been done for estimating the yield of milk by nursing mothers. It may be assumed that it does not reach the high figure of 34 oz per day as in Europe Accordingly weaning should begin from about the 4th month or the 5th month if the child be vigorous and its caloric needs are as mentioned before It becomes often necessary to begin weaning from an earlier age The reader may be referred to a pamphlet issued by the Indian Research Fund Association in 1942 as to "the use of fresh milk in infant feeding" The proportions of milk, water and sugar required in different ages during weaning are given in a tabular form.

* The following hormones take part:—Prolactin of pituitary body, adrenal steroids, *viz.*, 17-hydroxy-11-dehydrocorticosterone and des-oxycorticosterone, and thyroxine.

The yield of requisite amounts of milk by the nursing mother is possible only if she gets adequate amount of suitable food necessary for her maintenance and the milk produced 100 c c milk (*i e* 3 5 oz) contains approximately 1 4 g protein and 0 03 g Ca The following table gives the quantities of protein and Ca present in required amounts of milk during different periods of lactation —

Milk required at the end of		Protein content	Ca content
1st week	11 oz	4 4	0 094
1st month	14 oz	5 6	0 12
2nd ,,	22 oz	8 8	0 188
3rd ,,	25 oz	10 0	0 214
5th ,,	34 oz	13 6	0 291

The mother's diet should, therefore, in addition to satisfying the excess caloric and vitamin requirements, contain an excess amount of protein from which the milk protein can be manufactured and the excess amount of Ca to make up for that which is drained from the body through milk The milk proteins (Lactalbumin and Caseinogen) have a specific amino-acid constitution and can only be formed if all the necessary amino-acids are supplied in the food in sufficient amounts The same is also true when new tissues are formed by mother and child during pregnancy It is then obvious that the expectant and the lactating mother needs a substantially increased protein intake, a considerable part of which should be of animal origin It is, therefore, recommended that the lactating mother should have 2 g protein per Kg bodyweight Regarding Ca, as only one-third of the ingested Ca is absorbed, the lactating woman requires, in addition to her basal requirements (0 88g daily), thrice the amount of Ca lost through milk secreted It is to be remembered that the ability to sustain a good rate of milk production depends largely upon the nutritional condition induced by good feeding from the beginning of the lactation period and previously during pregnancy If the mother postpones her increase of food intake, including liberal supplies of vitamins and minerals, until her milk production has begun to decline, the results are apt to be less satisfactory both for herself and for the baby

It would not be out of place to have the following observations of Sir John Boyd Orr at the close of this article in the hope that at the time of adjustment of political, social and religious differences existing in this country, the inherent right of every individual of this country to get the minimum needs for the fullest development of his health and physique is simultaneously recognized and conceded —

(*i*) "If faulty diet is to be eliminated, the purchasing power of the poorest must be related to the price of a diet adequate for health, and this adjustment must be accompanied by education on the importance of food for health and the relative nutritive values of different foods "

(*ii*) "The right of every individual to the means of attaining his full inherited capacity for health and physical fitness should rank equal with his right to religious and political freedom"

BOOK REVIEWS

The Idea of Nature—By R G Collingwood, Pp. 183, Oxford University Press, 1945 Price 10s

R G Collingwood, late Professor of Philosophy, Oxford, did not confine his studies to purely philosophical subjects, but also made valuable contributions to aesthetics, history and political theory The book under review was left by him at the time of his death, in an incomplete form, and was edited for publication by his friend, Professor T M Knox It contains an unusually lucid and systematic exposition of the subject and is a striking testimony to the width of learning and power of exposition of the author It can be highly commended to those who seek a bird's eye view of the subject

According to the author, there has been in the history of European thought three periods of constructive cosmological thinking, periods in which the idea of nature came into the focus of thought, the subject of intense and protracted reflection, and consequently, it acquired new characteristics which in their turn has given a new aspect to the detailed study of nature that has been based upon it The word 'Nature' has a dual significance It is most frequently used in the collective sense as the sum total or aggregate of natural things *i e*, "to indicate whatever can be sensibly experienced, together with the occasions and conditions of what can be sensibly experienced and the modes of their inter-connections (Stebbing)". There is another, which is its proper sense, when nature refers not to a collection, but to a principle which makes its possessor behave as it does.

The detailed study of natural facts is commonly called natural science is in short science , the reflection on the principles, whether those of natural science, or in any other department of thought or action is commonly called philosophy. Restricting philosophy to denote reflections on the principles of natural science, it follows that natural science must come first in order that philosophy may have something to reflect on , but the two things are so closely related, that natural science cannot go on for long without philosophy beginning ; and philosophy reacts on science out of which it has grown by giving it in future a new firmness and consistency, arising out of the scientist's new consciousness of the principles on which he has been working. It is the aim of the author to give a short account of the evolution of the philosophical principles underlying the development of natural science since time of the Greeks. He distinguishes three periods of cosmological thinking in European thought, the Greek, the Renaissance and the modern view of Nature

Greek natural science, according to the author, was based on the principle that the world of nature is permeated or saturated by mind Greek thinkers regarded the presence of mind in nature as the source of that regularity or orderliness in the natural world, whose presence has made a science of nature possible According to the Greeks, the world of nature is not only alive but intelligent The life and intelligence of creatures inhabiting the earth's surface and the regions adjacent to it, represent a specialized local organization of the all prevading vitality and rationality, so that a plant or an animal participates in its own degree psychically in the life processes of the world soul and intellectually with the world mind, no less than it participates in the physical organization of the world body

Each cosmological movement is followed by a movement in which the focus of interest shifts from nature to mind The fundamental axiom of Greek thought about mind is its immanence in body ; but in Socrates, Plato and Aristotle we find assertions that the rational soul or mind operates independent of the body In his discussion of the theory of knowledge, Plato contrasts the bodily mind of appetite and sense with the purely intellectual apprehension of forms, which is effected by the rational soul's independent and self contained activity without any help from the body , again in his doctrine of immortality, the rational soul enjoys an eternal life unaffected by the birth or death of the body belonging to it

The permanent contributions of Greek thought to the philosophy of nature are, first in the region of physico-mathematical sciences , the Pythagorian doctrine that the solution of problems of physics was to be apprehended from the standpoint of mathematics, and Plato's doctrine of forms. As an illustration of Plato's influence on present-day physico-mathematical-speculations, the example of Jeans is cited. According to the author 'Jeans converging with Plato thinks the immaterial reality on which nature depends for its existence, primarily as a complex of mathematical forms, and secondly quite in Platonic manner, as a God who thinks these forms, a geometrician God".

Aristotle is the great antique philosopher of biology According to him Nature was characterized not only by change, but by effort or nisus or tendency

to change in certain definite ways. All processes involve a distinction between the potential and the actual—the potential is the seat of a nisus in virtue of which it is forcing its way towards actuality. This conception of nisus as a factor running through the entire natural world with its teleological implication about the ends towards which natural processe are directed, was at one time rejected by modern science as a piece of anthropomorphism, but is now again finding acceptance with suitable modifications by modern evolutionary philosophers. The essential difference between the Greek and modern view of nature is that according to the former all changes are cyclical while the modern view is that they are progressive.

The post renaissance cosmology gradually evolves out of the astronomical discoveries of Copernicus, Tycho Brahe, Kepler The discovery of the laws of mechanics by Galileo and of magnetism by Gilbert, the generalization of the laws of motion by Newton and his formulation of the laws of gravitation, established the mechanistic theory of nature, which reigned supreme till recent times The great forces of nature, like gravitation are entirely determined by the configuration of masses Thus configurations determined their own changes, so that the circle of scientific thought was completely closed

Nature is no longer an organism but a machine, in which changes and processes are produced and directed not by final causes, but by efficient causes, they are not directed towards the realization of any thing not yet existing, *i e*, teleology is banished From this quantitative view of nature certain concepts had to be banished, *e g*, qualities, mind These had to be accounted for elsewhere and gave rise to the two substance theory of matter and mind, first promulgated by Descartes Variants on the two substance theory are the different monistic theories (*i*) the materialistic theory of Gassendi, according to which the quantitative and mechanical nature described by Galileo is the only reality, and mind was the peculiar kind of pattern or structure of material elements, (*ii*) the one substance theory of Spinoza, in which there is only one substance God with two attributes extension and thought and (*iii*) the idealistic theory of Berkeley, who took up the view that if substance exists on its own rights and depends on it alone, then that substance is mind. Nature as it exists empirically for our every day perception, is the work or creation of mind ; nature in Galileo's sense, the purely quantitative world of the physicist, is an abstraction from this. According to Kant's form of idealism, nature, *i.e.*, the physicist's nature is not an arbitrary or irrational creation of the mind, but an essentially rational and necessary product of the human way of looking at 'things'. When the question is asked what are these 'things in themselves' are, Kant replies we do not know. The astounding success of mathematical physics founded in the seventeenth century has, in the view of Whitehead, been the ruin of modern philosophy. It has oscillated in a complex manner between three extremes There are dualists who accept mind and matter on an equal basis and two varieties of monists those who put mind inside matter, and those who put matter inside mind

The modern views of nature are still in the process of development, and are less easy to summarize It was noticed towards the end of the eighteenth century that there was a great deal of analogy between the processes of the natural world as studied by natural scientists, and the vicissitudes of human affairs as studied by historians The latter had introduced in their historical studies, the concepts of progress, change and development Transferred into the terms of natural science, the idea of progress, became that of evolution, and marked a crisis of first importance in the history of human thought

It had been an axiom with the Greeks that nothing is knowable unless it is unchanging, from which it followed that since the world of nature, is constantly changing, a science of nature is not possible According to the Renaissance view, behind the world of changing secondary qualities, there was the world of substance or matter, itself not subject to change, but whose changing arrangements and dispositions were the realities whose appearance to our sensibilities took the shape of secondary qualities In addition there were the 'laws', the so called laws of nature, according to which these arrangements and dispositions changed These two things, matter and law were the unchanging objects of natural science

The evolutionary concept of nature leads to certain consequences Unlike the Greek view, change is no longer cyclic but progressive, in which new things are constantly emerging A further consequence is that nature is no longer mechanical A machine is essentially a finished product or closed system, it will not begin to function as machine, unless completed With the banishing of the mechanical view of nature the idea of teleology in a modified form is again reintroduced. Every thing in nature persevere in its own becoming, to continue its process of development, in which it so far as it exists at all, it is already engaged Evolutionary philosophers like Lloyd Morgan, Alexander and Whitehead are frank in their acceptance of the Aristotelian concepts of potentiality, nisus and teleology.

The other great revolution in our cosmological views has been brought about by the recent developments of physical theories. We have to compare

the old concept of classical physics, in which motion is something external added to matter, to the recent electron theory of matter, in which every electron is in a state of activity The old dualism between matter and energy is replaced by Einstein's theorem of the equivalence of mass and energy These developments lead to the view that matter is inherently and essentially activity, *i e*, substance and activity are not two but one The importance of the frame of reference of the observer in the theory of relativity, the introduction of the principle of indeterminism in physics necessitated by the acceptance of quantum theory, the replacement of causal by statistical laws show how far we have travelled from the Newtonian conceptions of classical physics These results have induced certain physicists like Jeans and Eddington to turn into philosophers, and to infer certain conclusions which they consider to be given by recent physical theories on the nature of God, and on the freedom of human will Besides the speculations of such amateur philosophers, the book contains accounts of cosmological theories of two professional philosophers like Alexander and Whitehead In these attempt is made to unify the biological and the physical aspects of nature as revealed by recent development of science Whitehead asserts that reality is an organism, *i e*, every existing thing resembles a living organism in the fact that its essence depends not on its components only Nature is not only an organism but a process The activities of an organism are not external accidents, but they are united in a single complex activity which is the organism Substance and activity are not two but one—a conclusion which follows from new theories of matter The process of nature is not merely a cyclic or rythmical change, it is a creative advance, the organism is undergoing or pursuing a process of evolution in which it is constantly taking new forms and producing new forms in every part of itself

'The cycle of modern thought' states the author from Descartes and Newton to Whitehead recapitulates the cycle of Thales to Aristotle But the recapitulation is not a mere repitition, it has taken up into itself first the body of Christian theology, and derived from that theology, the body of modern science, the new physics of the seventeenth century and the new biology of the nineteenth In Whitehead's work all these conceptions of the new sciences have been fused to a new view of the world, which is not only simple and coherent in itself but has consciously connected itself with the main tradition of philosophical thought.'

To the reviewer the thought which comes upper most during the reading of the present book, is the continuity and development of philosophical ideas in Europe from the time of the Greeks to the modern age. How intimate has been the connection between scientific theories and philosophy of nature. By contrast it appears how totally lacking at present in this country is the contact between science and philosophy. Serious study of Western science has been going on in this country for over 75 years, and already many significant contributions have been made in many branches of science and mathematics So far our professional philosophers appear to be unware of the significance of these impacts of science on philosophy Science cannot take root in this country and form an integral part of the cultural heritage of our people, until a conscious attempt is made to link up the modern trend of Western philosophy of nature with our traditional schools of philosophy. This work cannot be undertaken by the professors of philosophy alone, but will require the co-operation of scientists who have made significant contributions to the development of biological and physical sciences

D M B

The Diffraction of X-rays and Electrons by Free Molecules—By M H Pirenne, Dr Sc, Pp xii + 160 2 plates. The University Press, Cambridge, 1946 Price *12s 6d* net

From the title of the book it would appear that it was intended to deal with diffraction of x-rays and electrons by free molecules Actually, however, the book comprises a survey of the results of theoretical and experimental investigations on diffraction of x-rays by both atoms and molecules in the free state, and these results have been compared with similar results contained in the case of diffraction of electrons The theoretical discussions have not been given in detail and only the final results have been compared with those observed experimentally, but references to the original work in which the details can be found have been carefully included

The first chapter deals with coherent scattering of x-rays by atoms and with the atomic scattering factor The second chapter gives a discussion about incoherent scattering of x-rays by free electrons and atoms In chapter III a brief discussion of intensity of characteristic x-radiation and dependence of atomic scattering factor upon wave-length has been given. Diffraction of x-rays and electrons by atoms has been discussed in the next two chapters and experimental results observed in particular cases have been compared with those expected theoretically Chapter VI and VII deal respectively with Debye's theory of scattering of x-rays by molecules including experimental results obtained to verify the theory and the influence of neighbouring molecules on such a scatter-

ing in the case of gases and liquids Chapter VIII and IX give a discussion of influence of thermal vibrations of molecules, rotation of groups in some particular molecules and number of bonding electrons in the molecules on the diffraction of x-rays and electrons by such molecules Chapters X and XI are devoted to the methods of determining structure of the molecules from results of investigations on diffraction of X-rays and electrons by the molecules in the free state The details regarding the technique required for such studies and the substances studied so far are given in the next two chapters

There are 82 illustrations and two plates in the book. A bibliography of 187 references has also been included The author himself has made valuable contributions in this line of research and his attempt to present a thorough survey of the work done so far in this line has been successful This book will certainly serve as a useful book of reference to research workers and postgraduate students interested in this particular topic The price of the book, however, seems to be a little too high

S C S

The Mathematical Discoveries of Newton—By H W Turnbull Blackie & Sons Ltd, London and Glasgow Price 5s net

This small very readable book consisting of 68 pages has grown out of two lectures given by the author at the Mathematical and Physical Societies of the University of Edinburgh at the tercentenary of Newton's birth. It contains an account of some of the famous discoveries by Newton in Mathematics such as the Binomial Theorem, the Differential Calculus (called Method of Fluxions by Newton), quadrature (integration), solution of equation, Interpolation by finite differences, and several of the beautiful geometrical theorems which are associated with the name of this foremost discoverer in the field of Mechanics The students of Mathematics will find great interest in the discussion by the author of the lines of thought by which Newton arrived at the final results I believe very few Indian Mathematicians take interest in Newton's Principia on account of obvious difficulties The present tract will to some extent supply their need in this respect by presenting within a small compass some of Newton's magnificent ideas in the way they occurred to him The preliminary portion of the lecture gives some account of the pre-Newtonian ideas on certain mathematical results and of the teachers and noted contemporaries of Newton The omission of controversies in this small tract will be appreciated by the reader

N R S

Text Book on Spherical Trigonometry.—By W M Smart Cambridge University Press

This is the fourth edition of the book by the author, the first edition of which was published in 1931 In addition to the contents of the previous edition it contains data regarding the 1941 determination of the solar parallax Since Ball's Spherical Astronomy had gone out of print Smart's book has been largely used by students of Astronomy both in the English Universities and in India It is quite handy and contains information on most of the important topics which a student of Spherical Astronomy desires to have By suppressing such topics as Figure of the Earth, Map Projection, Transit of Venus across the Sun, Generalised Instruments etc, but retaining the discussions of all other traditional problems of Spherical Astronomy, the author has found space to treat amply some topics of present day importance These constitute the chapters on The Proper Motions of the Stars, Astronomical Photography, Determination of Position at Sea, Binary Star Orbits and discussion of the heliographic co-ordinates so useful in connection with the motion on the Sun's surface The Appendices added in the previous editions have been retained The book is well printed and there is no doubt it will be very useful to students and teachers alike

N R S

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

WILT DISEASE OF *LAGENARIA VULGARIS* SER.

In April 1946 a few seedlings of *Lagenaria Vulgaris*, Ser were seen to wilt suddenly after a few days' growth. The nature of wilt and subsequent changes of the leaves were very carefully noted down. As a result of observation it revealed that the wilt was caused by the attack of a pathogen and not of any physiological reason.

In the primary stage the infection starts in the cotyledon first. When both the cotyledons are completely destroyed, the next upper leaf is then infected. As a result of infection the whole margin turns pale and then gradually wilts and becomes dried up and crumpled and is completely destroyed. But in some cases the cotyledons and leaves have been attacked simultaneously. Subsequently with the attack of the pathogen the whole seedling is destroyed.

On microscopic examination of the infected cotyledon and leaves no clear conclusion could be drawn.

Isolation of Pathogen

The causative organism was isolated aseptically in Potato Dextrose Agar Medium in the standard method. White cottony mycelium appeared on the third day. Subsequent subcultures were made immediately in the test tube with medium. White heavy cushions of mycelium developed around the inoculum. Subsequently growth was relatively rapid. Upright growth of the mycelium ensued along with the surface of the medium. Cultures were kept at ordinary Laboratory Temperature and Humidity. Very quickly aerial mycelium over the entire surface to a height of 1.0 to 1.5 mm was developed. Within five days characteristic thick mat of mycelium was developed over the whole surface of the medium. On this mat of mycelium characteristic brown bodies appeared. With the gradual development the bodies multiplied in number and turned deep brown in colour. These bodies were carefully taken out and examined under the microscope. Microscopic examination revealed that those were nothing but deep brown perithecia with innumerable long pointed processes with bulbous base. The perithecia are more or less globose to sub-globose and having dimension about 0·16 mm. to 0·10 mm. Mycelium is hyaline, septate in nature. Innumerable conidia were seen to cut off from the apex of unbranched conodiophores in basipetal succession. Conidia are more or less rounded, truncate or bluntly apiculate at one end and more or less constricted in the middle, having dimension about 45μ to 55μ in length and 22μ to 26μ in width.

The nature of the perithecia and long appendages with bulbous base revealed the occurrence of Mildew on the leaves of the seedling of *Lagenaria vulgaris*, Ser and the causative pathogen is *Phyllactinia sp*. The observation was confirmed when a vigorous leaf from a seedling was cut off and a minute tissue was exposed and inoculated with mycelium along with the medium. After inoculation the leaf was placed on damp blotting paper in a petridish. By the sixth day vigorous infection resulted the surface of the wound bearing patches of mycelium and further growth caused the complete destruction of the leaf. Cross inoculation confirmed the above statement that the wilt is caused by *Phyllactinia sp*.

Some Phycompycetous fungi have so far been reported[1] to occur on the leaves of *Lagenaria vulgaris* Ser. Also Salmon and Reed[2, 3, 4] reported the occurrence of Mildews on Cucerbits except the Spp of *Phyllactinia*. So the wilt caused by *Phyllactinia sp* is for the first time reported to occur on *Lagenaria vulgaris* Ser.

Asok Kumar Kar

Botanical Laboratory,
Presidency College
Calcutta, 20-8-1946

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CO-OPERATION IN SCIENTIFC EFFORT

At a recent meeting of the Chemical Engineering Association of the Science Institute at Bangalore, Sir J. C. Ghosh made an impassioned appeal for greater co-operation among scientists and for joint effort for a common cause even to the extent of self-effacement. These are noble sentiments, but, unfortunately, the underlying spirit is generally forgotten. Even if there is no self-effacement (which

calls for too much sacrifice!), the scientists can at least show some mutual tolerance and sympathy Even this spirit is often lacking.

During the past two years, we are making the most strenuous efforts to demonstrate the possibilities and to popularise the use of vegetable milks as articles of human food. Our attempts are based on the results of a very extensive series of scientific studies which are being steadily published in *Current Science, Science and Culture, Annals of Applied Biochemistry and Medicine* and other journals We have shown that, among the natural sources so far investigated, soya-bean gives the best milk We have not only standardised the conditions for preparing the milk, but have also followed up with producing it on a semi-large scale We have also conducted a quite extensive series of human feeding experiments and have shown that the milk and the related products are not only safe and nutritious, but also preferable to cow's milk because of its very easy digestibility in the case of infants and invalids —especially when the digestive functions are very weak Our findings are open to verification by any investigator who may be interested To further demonstrate and to apply our findings, we require the co-operation of the agriculturist to grow the bean , of the Government and the administrators for funds ; of engineers in fabricating improved types of equipment , education and public health authorities for facilities and co-operation in conducting further trials , of medical colleagues for systematic observations, of the consuming public for sympathetic interest and helpful suggestions , and of fellow scientists for sympathy

We have no doubt already secured a considerable measure of support, but the whole effort has nevertheless been a very stiff uphill task We have had, and are still continuing to have, difficulty in every direction The most serious obstacle has been the prejudice and even antipathy of our own fellow scientists. It is only our confidence in the ultimate value of the efforts that keeps us going.

We have already critically surveyed the position in regard to cow and buffalo milk and related products in the country An expended dairy industry is no doubt most desirable ; but considering the present conditions and the increasing pressure on land for food crops, it is doubtful whether the average consumption can be increased by even one ounce per head of population. That would represent an extra production of about thirty million pounds of milk per day. It will be a great achievement if even the present average is kept up, especially in areas where the population is perceptibly increasing. Use of imported milk powder provides temporary relief especially in a few big cities like Bombay. Even this costs some crores of rupees to the country Milk powder is not however going to solve the country's milk problem The solution should come from within Oil bearing seeds are our main hope for the future and by suitable combination of materials and processing, it should be possible to evolve a composition that will not only be quite palatable but also highly nutritious By using such milks, for which there is considerable scope, we can straightway raise the nutrition level of our people This new line of development will therefore deserve the fullest possible support from both the State and the people

At the recent Empire Scientific Conference, Prof M N Saha is reported to have complained about the inadequacy of encouragement and support for the fundamental scientist From our fairly intensive experience of the past six years in different lines of applied research, we may state that the Applied Scientist is also in the same plight, with the added disadvantage that he has very little publishable work and that his work in often dubbed as routine and receives very little recognition from fellow scientists It is now becoming increasingly difficult to attract and still more so to retain really talented workers in the field of applied science which is so much talked about but really receives very little encouragement and support The conversion of a laboratory finding into a semi-large operation is a veritable agony, and, in most cases, there are so many difficulties that one often feels like giving up the whole undertaking The ultimate practical success is uncertain with numerous factors unconnected with science—often determining the issue

The industrial advance of Europe and the still more spectacular rise of America is due to the close co-operation between different branches of science A number of specialists have to join together to apply a scientific finding The recent spectacular success in the large-scale production of Penicillin and the still more sensational Atom bomb are outstanding instances It is this kind of intensive collaboration that we require if India is to advance in the field of applied science The average Indian investigator is not intellectually very much inferior to his colleague in Europe or America, but whereas the foreign investigators work as a team, the Indians are not only disunited but even weaken each other's efforts through want of mutual sympathy Unless we get over this defect, we cannot hope to achieve much in the field of applied science.

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S. S. DE

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Bangalore, 9-9-1946.

CHEMOTHERAPY OF TUBERCULOSIS

THE successful chemotherapy of many bacterial infections does not yet extend to tuberculosis. This may be either due to the peculiarities of the tubercule bacillus, to the unusual tissue responses in tuberculosis, or, to the limited chemotherapeutic properties of drugs studied so far[1]. Gold in the form of some salts containing sulphur in the molecule is being largely used in clinical practice. Seldom a gold compound is found to have any pronounced bactericidal action on tubercle bacilli *in-vitro*, but it is believed that it has some value in certain conditions of the disease. It may play its rôle in combating the disease either by increasing the opsonin titre of the serum[2], or, by some other change, or changes the nature of which is not known.

Certain sulpha drugs and sulphones have been tried but in these cases also a difficulty arises for a systematic study for the facts that *in-vitro* activity bears little relationship to *in-vivo* activity, and that the tuberculosis in laboratory animals differs considerably from that in man. Feldman *et al*[3] noticed an activity of "promin" in guineapig, but results in human cases are disappointing[4]. Similarly, according to Benson and Goodman[5] the efficacy of "diasone" in man is questionable. "Promizole" (4, 2'-diaminophenyl-5'-thiazole sulphone) has certain advantages, but it also does not meet all the clinical requirements for the perfect tuberculo-chemotherapeutic agent[6].

It may be said that the fundamental condition of the effectiveness of a sulpha compound against tubercle bacillus may also be due to its power of depriving *p*-amino benzoic acid that may be considered[7] to be essential for the growth of the tubercule bacillus. It would, accordingly, be of interest to study the effect of sulpha compounds not affected by the presence of *p*-amino benzoic acid[8] on the growth of tubercule bacillus, and also to note the influence of gold when linked to the above type of sulpha compounds through a sulphur atom. With these objects in view a systematic investigation has been undertaken. The gold compounds are being prepared from thioglycolyl derivative of sulphanilamide compound by reacting with aurous bromide in alcoholic solution. For obtaining the former, the sulpha or allied compound is reacted with chloroacetyl chloride, and the resulting acyl derivative on treatment with ammonium thiocyanate and subsequent reaction with ammonia affords the desired thioglycolyl derivative. Thus, *p*-amino methyl benzene sulphonamide[9] gave Au S. CH_2. CO NH. CH_2 C_6 H_4 SO_2 NH_2. Similarly other aurothioglycolyl (both N^4– and N^1–) derivatives are being obtained from known compounds of the sulpha drugs. Thus, sulphanilamide itself yields *p*-aurothioglycolyl amino benzene sulphonamide and *p*-amino benzene sulphon (aurothio glyocl)—amide containing 43.83 and 43.42 per cent of gold respectively. Freshly prepared aurocompounds are practically colourless but on exposure to light and air the color gradually darkens. The chemical characteristics of the compounds are being published elsewhere, and the study on their chemotherapeutic properties in retarding the progress of tuberculosis in guinea pigs would be followed.

U. P. BASU
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Bengal Immunity Research Laboratory,
Calcutta, 23-9-1946

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ON A SIMPLE METHOD OF CONTROLLING *AGROTIS YPSILON*. ROTT. IN TOBACCO PLOTS

THE year 1945 showed much infestation for cutworm—*Agrotis ypsilon*, Rott. This was probably due to heavy rain and flood during the year. According to Fletcher and Woodhouse[1] "moths are

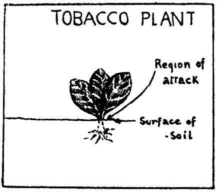

FIG. 1 Showing the region of attack

apparently attracted to the wet mud and lay their eggs there." The above view is also corroborated by the fact that the tobacco plot under experiment remained under rain water for sometime and after wards showed very heavy infestation.

Nature of damage —The damage done is caused by the caterpillars of the insect—*A. ypsilon, Rott* The caterpillars avoid sunlight, remain under the soil during day time and come out at night to feed upon the plants, cut across the stem or the petiole just at the surface of the soil, generally when the plants are young.

Observation —Observation made on the nature of damage shows that the region of attack is always the portion of the plant at the surface layer of the soil (fig 1) It was thought that by protecting this portion of each plant, the extent of damage may be minimised Such individual protection is possible in tobacco plots because of wide spacing and because every plant is to be attended during cultivation

Remedial measure —Usual method of control by poison bait[2, 3] (Lead arsanate, Paris green etc) requires time and the percentage of damage comes down very slowly To avoid such delay in matters of control *i e*, to put an immediate effective check, a new method was tried, called hereafter 'paper-wrapping' method. According to this method a small piece of paper was wrapped around the basal portion of the stem so that 1″ of the paper remain above and 1″ under the soil as shown in fig 2 Ghosh[1] refers to a more or less similar method of protection by bamboo cylinder.

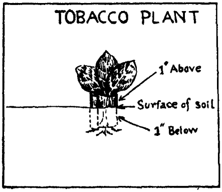

FIG. 2 Showing wrapping of paper.

Experiment —The efficacy of this method was tested at Rajshahi. Table I and III show that the paper wrapping system is a very effective and successful operation in protecting the plants and at the same time very economic and can be practised by any cultivator.

Table II shows that poison bait can not stop the damage immediately and some allowances for damage are given even after offering the bait,

TABLE I

EFFECT OF PAPER-WRAPPING IN CONTROLLING *A. Ypsilon*, ROTT

Area	Date of planting	Spacing	% of attack before remedial measure taken	Remedial measure	Date	Result
26 acre	18-11-45 to 20-11-45	3′ x 3′	25%	Paper-wrapping	30-12-45	No incidence

TABLE II

EFFECT OF POISON BAIT, FOLLOWED BY PAPER-WRAPPING SYSTEM

Area	Date of planting	Spacing	% of attack before remedial measure taken	Poison used	Date	Result till 3-1-46
20 acre	21-11-45 to 22-11-45	3′ x 3′	25%	Lead arsanate	30-12-45	Damage continued as usual, only few
,,	23-11-45 to 24-11-45	,,	,,	Paris green	,,	Caterpillars were found dead

This was, then, followed by paper-wrapping method and further damage did not occur.

TABLE III

EFFECT OF PAPER-WRAPPING AFTER HIGH PERCENTAGE OF DAMAGE

Area	Date of planting	Spacing	% of attack till 26-1-46	Remedial measure	Date	Result
14 acre	25-11-45	3′ x 3′	70%	Paper-wrapping	27-1-46	No incidence

It was first anticipated that ordinary paper may not be able to stand irrigation and parchment paper would be required. But it has been seen by trial that the ordinary paper serves the purpose well and would better suit the cultivator from the economic stand point of view If the colour of the wrapping paper be white, birds are attracted from the sky and they come down and take these away mistaking as food. This can be prevented by using paper with stem or soil colour.

This sort of control measure is possible in all transplanted crops with wide spacing such as cabbage, cauliflower etc where individual plant is to be attended during early period of growth and where there are no side shoots or tillering

Details will be published elsewhere

N DUTT

Bengal Agricultural Institute,
Dacca, 28-9-1946

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CONTROL OF RATS IN SEED-STORES

THE present note deals with a simple method of eliminating rodent infestation in pucca buildings and is specially applicable to seed stores By adopting this method rats have been successfully controlled in the seed stores of the Agriculture Department, Bengal

The method consists of burning a sufficient quantity of slightly moistened cow-dung cakes in the rooms after sealing up all crevices, holes, outlets etc The moistened cow-dung cakes burn slowly and smoke profusely The smoke when produced in sufficient quantity has apparently a chocking effect on the rats with the result that they get killed

It has been found that 10-15 srs of well dried cow-dung cakes for 1000 c ft of enclosed space produce the desired effect The cakes are to be made to burn slowly to produce the maximum amount of smoke. To achieve this the following procedure was found to be useful. An old empty kerosene tin packed tightly with broken cakes, upto about 8 inches. To a small piece in the centre, kerosene is applied and set fire to. The rest of the cowdung is piled upon the burning piece and packed in as tightly as possible Water is sprinkled upon the cow-dung cakes in order to discourage rapid burning.

The success of the measure depends to a large extent on the care with which the outlets from the rooms are sealed In practice complete success is attained by plastering the holes, crevices, etc, on the wall and floors carefully with thick mud. The cracks and chinks between the doors after they are closed and any other outlet through which smoke can escape are to be thoroughly sealed with mud plaster.

The doors and windows are opened after 24-hours All the rats present in the room are killed invariably Striking results are obtained when the initial infestation is high Thus in the seed store at Naogaon, in Rajshahi district, one hundred and twenty six rats, and at Pabna Sadar forty six, and at Chuadanga in Nadia district, twenty eight rats respectively, were destroyed by adopting this method.

It may be mentioned that the number of dead rats by itself is not a true measure of success of the method as this number depends only on the number of rats available for destruction. The number of living individuals found after the operation gives a true indication of the efficacy of the method During the last twelve months during which the fumigation has been carried out by the author, no living individual was found in the room after fumigation

The advantages of this method are obvious (1) the initial outlay is only a few annas worth of a readily available material ; (2) the operation can be undertaken in the seed stores even when the seeds are present in the rooms The seeds subjected to cow-dung smoke do not lose their viability (see table 1), on the contrary a slight stimulatory action is noticeable in some tests. (3) The smoke has been found to have a deterrant action on wheat weevils, though not on bruchids affecting gram.

EFFECT OF COWDUNG SMOKE ON SEEDS IN PERCENTAGE RATES OF GERMINATION

	Wheat		Gram		Lentil		Khesari	
No of tests	Before fumigation	After fumigation	Before fumigation	After fumigation	Before fumigation	After fumigation	Before fumigation	After fumigation
1	40 2	72	48	61	39	44 5	83	74 0
2	72	63	41	48	50	54 0		.
3	90	96 3	31	38	.			.

This fumigation method is only applicable in pucca buildings with strong walls. During one attempt in an old building, a few rats burrowed

their way through the wall and escaped outside though these were finally destroyed, thanks to the agility of the seedstore staff

The author's thanks are due to Rai Saheb S P Sen Gupta, Dy Director of Agriculture, Western Circle and Mr Utpal Sircar, Superintendent of Agriculture, Grow More Food Scheme for their encouragement and help during the course of the work.

S Y PADMANABHAN

Directorate of Agriculture,
Bengal, 30-9-1946

A NOTE ON A CLASS OF SOLUTIONS OF EINSTEIN'S ELECTRO-STATIC FIELD EQUATIONS

The following appears to be a general solution of Einstein's electro-static field equations in isotropic co-ordinates and with a particular functional relation between the electro-static potential and the component g_{44} of the metric tensor

The line element of the static field is taken in the form

$$ds^2 = - e^{u}(dx_1^2 + dx_2^2 + dx_3^2) + e^{w}\, dt^2 \qquad (1)$$

where the functions u and w are independent of t

The field equations for empty space are then solved by the assumptions

$$u + w = 0 \qquad (2)$$

and $$e^{w} = \tfrac{1}{2}(\phi \pm \surd 2)^2 \qquad (3)$$

where $\phi/\surd 8\pi$ is the electrostatic potential in Lorentz units The assumption (2) necessarily follows from the condition that the metric is to be Euclidean at infinity.

The field equations then reduce to

$$\nabla^2 w = \frac{1}{2}\left[\left(\frac{\delta w}{\delta x_1}\right)^2 + \left(\frac{\delta w}{\delta x_2}\right)^2 + \left(\frac{\delta w}{\delta x_3}\right)^2\right]$$

The substitution

$$w = -2 \log (1 + v) \qquad (4)$$

leads to Laplaces equation.

$$\nabla^2 v = 0 \qquad (5)$$

for the function v. The analogy with the classical theory is apparent.

Further

$$v = \frac{-\phi}{\phi \pm \surd 2}$$

The field calculated above will be valid if it be due to both matter and charge.

The Newtonian approximation of the above solution is obtained by neglecting all powers of v higher than the first We then have

$$g_{44} = e^{w} = 1 - 2v = 1 - 2\Omega$$

where Ω is the gravitational potential in gravitational units.

and $$\frac{\phi}{\surd 8\pi} = \mp \frac{v}{2\surd \pi}$$

The potential ϕ' in electrostatic units is, therefore,

$$\phi' = \mp v$$

Therefore,

$$\Omega = \pm \phi'$$

A particular distribution of matter and space charge which will produce this external field can be constructed by suitably continuing it across a boundary satisfying the conditions of continuity This can be done by assuming (2), (3) and (4) to hold in the interior of the boundary and choosing v to be a solution of Poisson's equation instead of equation (5) The internal field should satisfy the equations

$$G_i^k - \tfrac{1}{2} g_i^k G = -8\pi (M_i^k + E_i^k)$$

where M_i^k is the material and E_i^k the electromagnetic energy tensor

It can be shewn that with this choice of the internal field all the components of M_i^k vanish except M_4^4 which is given by

$$\nabla^2 v = -4\pi e^{-\frac{3}{2}w} M_4^4$$

in terms of the function v inside

The interesting feature of the above solution is that it is obtained only on the assumption of isotropic space defined by (1) in which condition (3) holds No further assumption regarding symmetry of space is made

Complete calculations will appear in due course

My thanks are due to Prof M N Saha, D Sc, F R S for his kind interest in the work

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Calcutta, 30-9-1946

A NOTE ON THE ESTUARINE FLORA OF THE KISTNA

HOOKER[1] says, "the four chief estuarine floras of India occupy the deltas of the Ganges, Irrawady, Mahanadi and Indus, but minor ones, notably those of the Kistna and Cauvery, occur at intervals commonly along the eastern shores, more rarely western" The estuarine flora of the Kistna occurs chiefly in the Repalle taluk of the Guntur district and the Divi taluk of the Kistna district, of the Madras presidency along the Coromandal coast

The estuarine flora of the Kistna is represented by 15 genera and 21 species distributed among 10 families The following is a list of the estuarine flora, a detailed and illustrated account of which is under preparation

I RHIZOPHORACEAE

1 *Rhizophora mucronata* Lamk , syn Rhizophora Candelaria W & A
2 *Rhizophora Candelaria* DC , Syn · Rhizophora conjugata Hensl , F B I ii 436 not of Linr
3 *Bruguiera cylindrica* W 8A , Syn Bruguiera caryophylloides Bl., Syn Bruguiera malabarica Arn.
4 *Bruguiera conjugate* Merr., Syn Bruguiera gymnorhiza Lam
5 *Ceriops Roxburghiana* Arn.

II COMBRETACEAE

6 *Lumnitzera racemosa* Willd

III MELIACEAE.

7 *Xylocarpus obovatus* A. Juss , Syn Carapa moluccensis Bedd.

IV SONNERATIACEA.

8 *Sonneratia apetala* Buch. Ham.

V. MYRSINACEAE.

9 *Aegiceras corniculatum* Blanco , Syn · Aegiceras majus Gaertn.

VI VERBENACEAE

10 *Avicennia officinalis* Linn
11 *Avicennia alba Bc* , Syn *Avicinnia officinalis* var, alba C B Clarke (in F.B.I.).
12 *Avicennia marina* Vierh
13 *Clerodendron inerme* Gaertn

VII EUPHORBIACEAE

14 *Excoecaria Agallocha* Linn

VIII ACANTHACEAE.

15 *Acanthus ilicifolius* Linn

IX. LEGUMINOSAE

16. *Derris uliginose* Benth.

X CHENOPODIACEAE

17 *Suaeda monoica* Forsk
18 *Suaeda nudiflora* Heq
19 *Suaeda meritima* Dumort.
20 *Salicornia brachiata* Roxb
21. *Arthrocnemum fruticosum* Hoq

I have pleasure in expressing my sincere thanks to Mr Wrench, I.F S , District Forest Officer, Guntur, for providing me facilities to visit the Kistna estuarine region.

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[1] Hooker, J D , A Sketch of the Flora of British India, p. 30, 1906.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. JANUARY, 1947 No. 7

PATTERNS OF PLANNING IN DIFFERENT COUNTRIES

'PLANNING' has been a permanent feature of most governments of the world ever since Soviet Russia set the example by establishing the State Planning Commission (the Gosplan) in 1921 A short account of planning in Russia is given in the accompanying article But the Philosophy and the pattern of 'Planning Machinery' has varied widely from country to country, and according to its traditions and standard of development has changed shape with changing conditions

Even in the United States, the classic land of private enterprise, a good deal of planning has been done under the name 'New Deal', and through such agencies as the National Resources Planning Commission The 'New Deal' owed its strength to the economic crisis of 1931, and though it was the baby of the late President Roosevelt, and is now being killed by the resurgence of Republican capitalism, it was a vigorous baby during thirteen years of Roosevelt regime and was responsible for much good work, amongst others the Tennessee Valley Authority, the construction of great dams over the Colorado and the Columbia Rivers by the Bureau of Reclamation The 'Brain-trust' formed by Roosevelt consisting of distinguished university men, and industrial employees, director of scientific and technical research institutes, and experts in different lines was the moving force behind the 'New Deal'

In the United Kingdom, the original home of private enterprise, the need for planning was not at first publicly recognized, but it has been gradually coming, and becoming a very important feature of administration. Between the first and second global wars, the Political and Economic Planning Society (P.E.P.), a private organization of which Dr L. Elmhirst is the chairman, has been doing 'private planning' of the fuel, power, steel and other industries, many of its findings being utilized in government legislations The scientific research departments (Departments of Scientific and Industrial Research, Agricultural Research, Medical Research) do a good deal of *planning* for research under the direction of the Lord President of the Council,* who may be said to perform the functions of the Minister of Planning in the U K Many of the chiefs of the present Labour Government, like Dr Hugh Dalton, Chancellor of the Exchequer, are strong believers in planning, and have set up bodies for effecting what Herbert Morrison calls the *Second Industrial Revolution* These bodies are working out measures for nationalization of all the productive agencies of the country like power, fuel, iron and steel industries, and plans for nationalization of land are said to be in contemplation Britain in accordance with her tradition does not believe in 'revolutionary measures', but is content to carry out reforms slowly within the framework of its time-honoured institutions

Sweden has a strong department of Democratic Planning, since the first World War of 1914-18, which has done immense service for the development and conservation of her resources As a result, though she has no colonies, and has most of her areas covered with snow, she enjoys a prosperity, and a standard of living for the common man which is comparable with only that of U. S A

France has a definite place for a 'Ministry of Planning' in her new constitution and Mr Gouin, late head of the State, is in charge of it.

PLANNING IN INDIA

In India, the idea of 'Planning' became familiar when the Indian National Congress under the personal

* This post was occupied during the war by Sir John Anderson, and, under the Labour Ministry, by Mr Herbert Morrison. For functions of the Lord President and Research Councils under him, see *Science and Culture*, past issues.

initiative of Netaji Subhas Chandra Bose, then President of the Congress, set up a 'National Planning Committee' in 1938, at a meeting of the conference of provincial ministers, held at Delhi on October 2 and 3 The Committee worked under the inspiring chairmanship of Pandit Jawaharlal Nehru for over four years and had the veteran economist Prof K T Shah of Bombay as its secretary The Planning Committee included a general body of 15 members (excluding the Provincial Ministers and certain representatives of the States who were ex-officio members), and its work was distributed amongst 29 sub-committees each devoted to a special subject, composed of eminent scientists, industrialists, technicians, economists, and representatives of public life, commerce, labour and social services Each sub-committee had a chairman and a secretary, all of them being honorary workers The sub-committees included subjects covering almost all the activities of a modern State and many of them have completed their reports giving objective pictures of the subjects under their purview and suggesting valuable measures and directives But owing to well-known circumstances, only some of these reports have been reviewed by the general sessions of the N P C and resolutions on only a few have been framed In the absence of authority, the Congress could take no effective action on them It is also understood that the Muslim League had also appointed a Planning Committee under the chairmanship of Nawab Ali Nawaz Jung Bahadur, distinguished irrigation engineer of Hyderabad, who had been also chairman of the River Sub-committee of the N. P C, but no reports of its activities have been published in the papers. A full list of members of the National Planning Committee, and list of sub-committees with names of chairmen and secretaries of the sub-committees as originally constituted are given in Appendix A There have been some changes in the list

During the war, a number of Indian business magnates issued what is called the "Bombay Plan" which aimed at doubling national wealth within 10 to 15 years. This was almost entirely a plan by the capitalistic interests, and though many of the ideas had been taken from the reports of the N P C, the framers had the usual businessmen's prudence to avoid mention of the name of the Chairman, Pandit Nehru or of the Congress anywhere in the pamphlet issued

Following the report of Prof A V Hill who was invited to advise the Government of India in 1944, the Government of India set up a Department of Planning and Development in 1944, with Sir Ardeshir Dalal as the Hon'ble Member-in-Charge The Department employed a small secretariat and appointed about 24 panels composed of non-official chairmen, honorary members and some wholetime technical officers The panels covered a wide range of industrial subjects, and we are told that some of the reports are being printed The Department took over the Council of Scientific and Industrial Research, which was first set up in 1941 as part of the Department of Supply and Industries, but its attempt to bring the other scientific sections* of the Government under its jurisdiction did not succeed The department also came into clash with the older departments of the Government who set up planning sections of their own, and refused to hand over either their own planning function or powers of execution to the new department In the formation of the Interim Government, the Department of Planning and Development finds no place.

Planning by Provinces and by Departments of Government of India

During and after war the Government of India and the Provincial Governments appointed any number of planning committees, development committees, fact-finding committees on many subjects It was given out that nearly 500 crores of rupees would be planned on the post-war development of works by the Central Government, and an equal sum by the Provincial Governments It is almost impossible to give a detailed list of all these plans The total number of pages covered by all the different plans, Provincial as well as Central, run well over 20,000 pages, as can be seen from the Appendix B.

Perusal of some of these plans show that some are merely superficial studies, ending with 'pious wishes', and it would be difficult to call any of them plan as they understand it in Soviet Russia or elsewhere, but apart from any intrinsic merit of the plans, it is apparent that a good deal of overlapping exists in the planning done by the different sections of the Central Government as well as in the plans made by the Provincial Governments and there are many important lacuna in planning †

Overlapping in Planning

To give some concrete examples the Government of India has given out that they want to found four higher technological institutes of the M I T

* These are The Imperial Council of Agricultural Research, Indian Research Fund Association (Medical Research), The Geological, Meteorological, Zoological and Botanical Surveys

† Apparently the late Government felt the necessity of co-ordination and set up a Co-ordination Committee of the Viceroy's Council (C C C), with Sir Eric Coates as Vice-Chairman and consisting only of official members of the secretariat rank, and it was proposed *to draw its secretariat entirely from civil service and Armed Forces* Further, a purely official Development Board was set up consisting of the Vice-Chairman of the C C.C. as Chairman, and Secretaries of the different departments as members.

(Massachusetts Institute of the Technology) type in four different regions of India, east, west, north and south. Every Provincial Government has also planned measures for the conversion of the present provincial engineering colleges into the higher technological institute type (late Government of Madras had planned four such engineering colleges for the needs of the Presidency but the present Government has given out its intention of following strictly Gandhian economy, so one does not know where the fourfold stream of engineers would find employment) The Indian Institute of Science has planned a Power Technology College We have seen plans of all these institutes before us and there exists a great amount of overlapping in their courses of study, training and general objective We do not mean to say that so many technological institutes may not be finally needed for a country of India's size, but we are sure that even if a small number of them were to be started now, they would give us much larger personnel than can be absorbed in the development works now under contemplation unless the Government starts gigantic constructive works of which there is no evidence yet It is, therefore, absolutely necessary, in the larger interests of the country, that the technological institutes now under contemplation be arranged in order of 'priority'. The remarks which have been made of planning in technological education may be made of many other schemes, but length of the article prevents us from going further into this matter

Lacuna in Planning

As example of an important lacuna in planning, we may cite the case of *fundamental research in science, economics and other basic subjects.* These subjects are mostly done in the universities, and, according to a strange decision of the Education Department of the Government of India, university education is a provincial subject, excepting in the case of the universities of Delhi, Aligarh, and Benares which they have started calling 'Central Universities'. This policy is fraught with the gravest menace to the efficiency of services and of the country, because the higher personnel is drawn from all universities and not alone from Delhi, Benares and Aligarh As far as we are aware, no provincial university has been asked by any of their Governments to give any scheme on the development of 'fundamental research', and the Provincial Governments are under the impression that fundamental researches on basic subjects are mere luxuries, and only technological and vocational schools are necessary for the uplift of the country.

Further, on account of introduction of communal ratios and political considerations, recruitments to higher posts in many universities and higher grade colleges are hardly made on merit basis, and we know at least of one university in which a distinguished university professor has been debarred from utilizing the grant given to him by the C S I R. because his superior officer thought that his preoccupation with research would impair his teaching capacity! We are convinced that if fundamental research is to flourish at all, it must be a Central Subject, but between the Central and Provincial Governments fundamental research is between the devil and the deep sea.

Yet the importance of 'fundamental research' has never been so strikingly brought out as during the second global war. The credits for the radar, the atom-bomb, the solution of the food-problem, the finance-problem, without which the allies could not have won the war inspite of vast superiority in men and materials, have all to be given to the university men engaged in fundamental research Nay, it is even being said that Germany lost the war because she placed too much reliance on 'engineers and made little use of her scientists'

In England, these points have no longer to be debated The Universities' Grants Committee asked in 1946 for a grant of 2 5 million pounds, but it was raised to 9 million pounds on the initiative of the Lord President himself (Herbert Morrison) to enable the universities and research institutions to completely overhaul their establishments on fundamental research. The Ministry has not invented, as the relevant department of the Government of India has done, any artificial distinction of Central and Provincial universities to escape their responsibilities.

It is all-important that before any decision is taken on any of the plans, Provincial or Central, (1) they should be examined on their own merits, for while many of the plans appear to contain very useful suggestions, a far larger number is mere 'castle-building in the air', (2) even when the plans are found to be sound, they should be co-ordinated by competent authorities, and arranged in order of priority, and quick decision should be taken on them, (3) the important lacuna in planning should be filled up by the setting up of new bodies

From the above review of planning in India it will be seen that much of the planning done by Government of India and Provincial Governments may be just *Wild Goose Hunting*, and if decision be taken to implement some of them, more money would be wasted than in the notorious Back Bay Scheme or the Mundi Hydro-electric Scheme.

Bungling with Planning

This 'Bungling' with planning on the part of Central and Provincial Governments is mainly due

to their want of appreciation of the benefits of planning, and ignorance of the philosophy and development of planning in Soviet Russia, and other countries, an account of which is given in the accompanying article We may state here that acceptance of principles of Marxism is not essential for planning, for Sweden has demonstrated that even on the existing framework of constitutional monarchy, as good planning can be done as in any country committed to communistic philosophy.

The main blunders of the late Government of India and the Provincial Governments in planning may be summarized as follows —

(1) They conceived planning as a *temporary measure* "Once we prepare a blue-print of a scheme, the planning section would be abolished, and the department should go on with the execution of the plan," said once a high official of Government of India, and this no doubt reflected the opinion of most of the members of Government

On the other hand, as our account of Russian planning in the next article shows, in order that planning may be effective, there must be a Central Planning Commission vested with proper authority, as an integral part of the Government, and it should be a continuous function of the Government as other departments like finance or trade are

It should be a fact finding body, *continuously* studying and investigating the conditions in every department of human activity all over the country, collecting and maintaining up-to-date statistics in agriculture, industry, health, education, communication and defence and other activities A properly organized Central Statistical Department should be an essential part of the C. P C , and the plans should be worked out in terms of 'Balanced Figures'

(2) The Central Planning Commission must be invested with proper authority

The Russian Gosplan was first a subordinate body to the Council of Labour and Defence, from 1921-1931 Though it did much good work, it was not very effective in framing the national policy. From 1931, its status was raised, and the President is not only made a member of the Sovnarkom (the Cabinet), but one of the two Vice-Presidents of this supreme body

(3) The functions of the Central Planning Commission should be (*a*) co-ordination of the plans of the different departments of Central Government, and of the Provincial Governments, (*b*) planning for central subjects.

The need for co-ordination has been emphasized. It has also been recognized by the Government of India when they set up the co-ordination committee, but it is ridiculous to think that the work can be done by merely a committee of secretaries already overburdened with routine work. The Gosplan in Russia employs for this purpose a huge permanent staff which consisted in 1935 of 2000 scientists and 4,000 persons of other work.

(4) The State Planning Commission must not be burdened with the task of execution of the plan Its functions would be more like that of the *architect*, and not of the executor of a building plan. The task of execution should be left to Ministries or Departments, authorities and other government or semi-private agencies But it should be certainly one of the main functions of the Central Planning Commission to supervise the actual fulfilment of the plan and make its report to the Cabinet

The above short review will probably convince the reader that the setting up of a proper planning machinery for a big and extremely backward country like India where various interests have to be reconciled is neither the work of the dilletante politician or businessman who wants to take up the job in a holiday mood and make a big show of it, nor of the bureaucrat whose imagination and power of thinking have been blunted by continued file work. We have to mobilize the best brains of the country, as the Indian National Congress did, inside and outside of Congress ranks, who would be prepared to devote all their time and mind for the work for a considerable period

APPENDIX A

(*a*) *List of Members of the National Planning Committee*
Jawaharlal Nehru (Chairman), Sir M Visvesvaraya, Sir Purshottamdas Thakurdas, Dr Meghnad Saha, A D Shroff, K T Shah, A K Shaha, Dr Nazir Ahmad, Dr V S Dubey, Ambalal Sarabhai, Prof. J C Ghosh, J C Kumarappa, Walchand Hirachand, Dr Radha Kamal Mukerjee, and N M Joshi

(*b*) *List of Representatives of Governments*

Hon Mr V V Giri, Hon Mr L M Patil, Hon. Dr Syed Mahmud, Hon Mr C J Bharuka, P B Advani, M B Pillai, M Khurshid, Shuaib Qureshi, A Mohiuddin, M S Ramchandra Rao, S M Pagar, C A Mehta

(*c*) *List of the names of Chairmen and Secretaries of the Sub-Committees*

1 *Rural Marketing & Finance—Chairman* The Hon'ble Mr Ramdas Pantulu; *Secretary*. Dr Sudhir Sen.
2 *River Training & Irrigation—Chairman*: Nawab Ali Nawaz Jung Bahadur, *Secretary*· Mr U. N. Mahida
3 *Soil Conservation & Afforestation--Chairman*. Prof J. N Mukherjee, *Secretary* Prof. S P Agharkar
4 *Land Policy, Agricultural Labour & Insurance—Chairman*· Prof K T Shah, *Secretary*. Radha Kamal Mukerjee
5. *Animal Husbandry & Dairying—Chairman*: Sir Chunilal V Mehta, *Secretary*. Rao Bahadur M R. Ramaswamy.
6 *Crop Planning & Production—Chairman* Sir T. Vijayaraghavacharya; *Secretary*: Dr Bholanath Singh

7 *Horticulture—Chairman*: Dr G S Cheema, *Secretary* Mr Jabir Ali
8 *Fisheries—Secretary* Dr S B Setna
9. *Rural and Cottage Industries—Chairman* Shri S C Das Gupta, *Secretary* Dr C. A Mehta
10 *Power and Fuel—Chairman* Dr Meghnad Saha, *Secretary* Prof A K Shaha
11 *Chemicals—Chairman* Dr J C Ghosh, *Secretary* Prof. R C Shah
12. *Mining and Metallurgy—Chairman* Mr D N Wadia, *Secretary*: Dr V S Dubey
13 *Engineering Industries including Transport Industries—Chairman* Shri P N Mathur, *Secretary* The Hon'ble Mr M N Dalal
14 *Manufacturing Industries—Chairman* Shri Ambalal Sarabhai, *Secretary* Dr Nazir Ahmad
15. *Industries connected with Scientific Instruments—Chairman* Dr P N Ghosh, *Secretary* Principal G R Paranjpe
16 *Labour—Chairman* Shri N. M. Joshi, *Secretary* Shri V R Kalappa
17 *Population—Chairman* Dr Radhakamal Mukerji, *Secretary* Dr B C Guha
18. *Trade—Chairman* Shri Kasturbhai Lalbhai, *Secretary* Prof J J Anjaria
19 *Industrial Finance—Chairman* Mr A D Shroff, *Secretary* Shri J K Mehta
20 *Public Finance—Chairman* Prof K T Shah, *Secretary* Prof Gyan Chand
21 *Currency & Banking—Chairman* Shri Manu Subedar, *Secretary* · Prof C N Vakil
22 *Insurance—Chairman* Sir Chunilal V Mehta, *Secretary* Shri K S Ramchandra Iyer
23 *Transport Services—Chairman* Dr D R Gadgil, *Secretary* Dr F P Antia
24 *Communication Services—Chairman* Sir Rahimtulla Chinoy, *Secretary* Dr S K Mitra
25 *National Housing—Chairman* Shri S D Prabhavalkar, *Secretary*: Dewan Bahadur V G Shete
26 *Public Health—Chairman* · Col S S Sokhey, *Secretary* Dr J S Nerurkar
27 *General Education—Chairman* Sir S Radhakrishnan, *Secretary*: Shri E W Aryanayakam
28 *Technical Education—Chairman* Dr Meghnad Saha, *Secretary*: Mr P Parija
29 *Sub-Committee on Woman's Role in Planned Economy—Chairman* · Rani Lakshmibai Rajwade, *Secretary*. Smt Mridula Sarabhai

APPENDIX B

	Pages
(1) Reports of the Provincial Planning Committees (printed)	3,328
(2) Reports of the various sub-Committees of the Government of India	
Report of the Coal Commission	--
Report of the Bhore Committee	1,201
Report of the Industrial Research Planning Committee	150 (Approx)
Post-War Educational Plan (Sargent Report)	200 (Approx)
Report of the various other Educational Projects	—
Report of Power & Irrigation Projects	—
Reconstruction Plan of the Indian Meteorological Dept	25
Post-War Plan for Astronomical and Astrophysical Observatories	23
Reconstruction Plan for the Geological Survey	25 (Approx)
Post-War Forest Policy for India	50
Reconstruction Plan for the Zoological Survey	--
Burn's Report on the Technological Possibilities of Agricultural Development	127
Kharegat's Report on Agriculture & Animal Husbandry in India	—
Report of the Fisheries Departments	—
(3) Reports of the Industrial Panels set up by the late Dept. of Planning and Development	—
(4) Pamphlets on Policy Committees	—
(5) Pamphlets published by the National Planning Committee	3,500
(6) Miscellaneous	1,000
Total	20,000 (Approx)

THE DEVELOPMENT OF SOVIET ECONOMIC SYSTEM*

THE author is a Russian who left the U S S R. in the summer of 1920, then settled in Prague and was attached to the Russian Economic Study Centre of Prof. S N Prokopovich in Prague With the aid of the abundant material received from Soviet Russia at this and other Institutions, he had since been studying the development of the economic and social system in his own country of Soviet Russia from the outside. His knowledge is both extensive and intensive, as is apparent from the voluminous bibliography, mostly in Russian, given at the end of the book This appears to be a strictly academic and scientific study written without prejudice or passion, and the main events of the Soviet economic experiment are described in cold, unimpassioned language, characteristic of a scientific observer. Both sides of the picture,—the not infrequent mistakes committed by the Soviet enthusiasts in the earlier stages, as well as the dazzling successes achieved later, the follies of childhood as well as the saner measures of maturer years of the Soviet Republic are recorded with the same logical coldness Propagandists, either

* An Essay on the Experience of Planning in the U. S S. R.—by Alexander Baykov, Lecturer in the Department of Economics and Institutions of the U S S R., Cambridge University Press 1946, Price 30s.

of the left or the right variety, will hardly be able to reproduce honestly any passage to suit his need for newspaper outburst

The author distinguishes between five periods of the Soviet Economic history These are

1 The transitional period and period of war-communism (October 1917 to April 1921)

2 Period of Restoration and Preparation for the reconstruction of the National Economy (N E P) (April 1921 to 1927)

3 Period of Extensive Industrialization, Collectivization of Agriculture and Rationing (Rationing period 1927-1934)

4 Period of Intensive Endeavour to improve the country's Economy and Economic System (1934-1941)

5 The Second Global War period

The adventures of Soviet economic experiment during the first four periods which were widely different from each other and changed with the experience and external and internal political barometer are described under six main headings.

(1) Industry, (2) Agriculture, (3) Internal and External trade, (4) Public Finance, Credit and Money, (5) Labour, (6) Planning

The author describes, rather briefly, the mental attitude of the Soviet political leaders which led them to adopt the particular administrative measures during each period, the manner in which effect was given to them and the results which they produced The Soviets, guided by Marxist philosophy, were experimenting with human society on a scale never attempted before in human history The results of this experiment are worth serious study in a dispassionate manner, but very few have the temperament and opportunity for such a study It would be moreover extremely time consuming, and we leave to such a serious student study of the first five chapters in each of the four sections which narrate the main features of economic policy and economic development during these periods under headings (1) to (5)

PLANNING

We are concerned in this essay with adventures in 'Planning' by Soviet Russia during the fateful years between the first and the second world war In fact the invention by the Soviets of the technique of Planning as an integral part of administration is regarded by competent authorities as the unique contribution of the Bolsheviks to the theory and practice of government, and Sydney and Beatrice Webb, in their classical book on 'Soviet Communism'' mention that it is this unique feature in Soviet administration which induced them to take a journey to Russia for first hand information regarding planning at a time when they were nearing eighty Their classical account of Planning has not yet been surpassed for its lucidity or completeness, but the treatise before us give some very useful additional information—the ideas of Planning are supposed to have been contained in the Communist Manifesto of Marx and Engels

"It aimed at establishing a completely new organization of society, an organization in which industrial production would be directed, not by entrepreneurs competing among themselves, but by society itself, according to a plan designed to satisfy the needs of all citizens, society would expropriate from private ownership all means of production, transport, distribution, etc, and would dispose of them according to a definite plan and with a definite aim in view"

BEGINNINGS OF PLANNING

A State Plan for the electrification of Russia (Goelro) was worked out as early as the period of War Communism It embraced a vast project for a general reconstruction of Russia's national economy 'Together with the current, urgent task of organizing transport, eliminating crises in the supply of fuel and food, and organizing disciplined labour armies, there arises for the first time the possibility for Soviet Russia to approach a planned economic construction, on the basis of a scientific preparation and putting into practice of a State plan for the whole national economy'.

The Goelro Plan, in this period, was merely a wish. It began to be introduced into practice only with the establishment of the State Planning Commission (The Gosplan) on February 22, 1920, which developed its activity only during the subsequent period of restoration of the national economy

The Government issued the following 'Statute for the setting up of a State Planning Commission'

(1) A General Planning Commission is being established in connection with the Council of Labour and Defence (S. T O) for the purpose of working out a single, all-embracing State economic plan, on the basis of the electrification plan (Goelro) approved by the Eighth Congress of Soviets, and for general supervision of the execution of the aforesaid plan

The economic problems first on the list, particularly those to be carried out at the earliest date, namely, in 1921, are to be elaborated in detail by the General Planning Commission or its sub-commission taking into consideration the existing economic conditions

(2) The functions of the State General Planning Commission were defined as follows

(a) To work out a general State Plan as well as the means and order for carrying it out;

(b) To examine and co-ordinate with the general State Plan all industrial programmes and planning suggestions of the various departments and regional economic organizations in all branches of national economy. To establish a *rota* for the execution of the same,

(c) To work out a series of general State measures for developing knowledge and organizing the research necessary for putting the Plan of State

Economy into effect, and for employing and training the necessary personnel,

(d) To work out measures for acquainting the general public with N E P, the means for its execution and the forms for the corresponding organization of labour

(3) The State General Planning Commission, in carrying out its functions is entitled to communicate direct with all higher State and central departments and institutions of the Republic

(4) It is the duty of all the Commissariats and regional and local institutions to place at the disposal of the State General Planning Commission any information and material asked for, and to delegate responsible collaborators to provide the necessary explanations

(5) All planning suggestions arising in commissariats and departments and connected with problems of national economy, and all production programmes are to be submitted to the State General Planning Commission for examination and co-ordination with the State General Plan

(6) The Praesidium and members of the State General Planning Commission are appointed by the Council of Labour and Defence (a Committee of the Sovnarkom, the Supreme Cabinet) The chairman of the State General Planning Commission is granted the right of personally reporting to the President of the Council of Labour and Defence

(7) In carrying out its duties, the State General Planning Commission employs its own staff of collaborators Moreover, the Commission is entitled to enlist the services of individual specialists both for permanent or temporary work in the Commission It is likewise entitled to commission outside workers and remunerate them on a piece-work basis

From the very outset, the State Planning Commiss'on was given very wide powers for working out the general State Plan for the reconstruction of the country's national economy But most of the officers of the Gosplan appear to have been raw men and had no experience of planning The proper planning machinery to cope with the task set out had not yet been foreseen, nor was the Gosplan invested with requisite authority ; its president was subordinate to a committee of the Cabinet, had no direct access to the Cabinet, and therefore the recommendations did not carry much weight In fact, 4 years elapsed before they could draw up towards the close of 1925 the first 'substitute' for an annual State economic plan in the form of '*Control Figures of National Economy for* 1925'. These were not, however, approved by the Government and were rather caustically commented upon by Lenin :—

"There is too much about electrification and too little about *current* economic plans When I was faced with the Communist "wise men" who babbled and wrote nonsense about the plan in general without having read the book *The Plan of the Electrification of Russia*, nor understood its meaning, I had to dig their noses into that book . . . But in dealing with those who wrote it, I should have to drag them not towards but away from the book--to problems of current economic plans . The present task of the State General Planning Commission is not to concentrate on that (*i e*, the electrification plan) but to devote all its energy to working out current economic plans."

The first plan of National Economy to be actually worked out by the U S S R. Gosplan appeared in 1931 The cause for the prolonged delay which preceded the drafting of a first economic plan and the introduction of complete economic planning was the necessity of first creating the fundamental prerequisites for planning What were these prerequisites ?

Prerequisites for Planning

According to the author, Planning in its latest development presupposes the following

(1) The formulation of the aims pursued by the plan
(2) The existence of planning machinery
(3) The knowledge of what 'exists', that is, of the conditions prevailing at the start, of their elements and interdependence which will serve as a basis for the plan
(4) The drafting of the plan, *i e*, the embodiment of the general aims in concrete tasks, the fulfilment of which will result in the plan itself being fulfilled

The existence of these four conditions allows the *drawing up* of a plan, but does not yet provide the requisites for *planning*, that is, of carrying out the plan

The following conditions are necessary to make planning effective

(1) The decision of the authority in power to carry out the proposed plan, *i e*, the official approval of the plan and the issue of instructions and orders to put it into effect.
(2) The means of enforcing the execution of the plan, which must include the possibility of controlling the course of its fulfilment and of imposing penalties for failure to carry out orders issued by the planning authorities

Knowledge of What Exists

Let us begin with the examination of the 3rd prerequisite

Every act of planning, *in so far as it is not mere fantastic castle-building in the air*, presupposes a preliminary investigation of existing conditions Lofty aims and high-flown language are not sufficient for shaping the future It was at first attempted to obtain all this information by bringing into existence Conjuncture Councils of the U S. S R Gosplan, in which officials of various government departments interested in the plan were invited for information, advice and discussion as is now being done in the Goverment of India, but this system did not work, probably for the very same reasons as in India So this was replaced by the Central Statistical Administration which took over the task to organize conjunctural statistical observations Every administration in the U S S. R was obliged to collect statistical conjunctural data in their respective fields of work according to the directions

given by the Central Statistical Administration The knowledge of what exists was obtained according to the traditional pattern commonplace to statistical institutes all the world over, through a hierarchy of statistical bodies connected with the Commissariats, territorial administrative centres, industries

While these measures appear to have been fairly successful in obtaining the knowledge needed in all branches of government activities, it failed entirely in agricultural production

It was very difficult to obtain any statistics about agricultural production as the peasants were left in possession of their own private lands The difficulty of obtaining any reliable figures from the peasants and working out control figures was one of the causes which led to the suppression of private peasant proprietorship by force and institution of the system of collective farms and State farms

It was found, however, that the organization and programme of statistical observation was not closely linked to the problems of planning It was therefore reorganized in 1931 into the *Central Administration of Economic Accounting* and was made an integral part of the State Planning Commission Its task was to work out and ratify the system of indices of accounting for the entire national economy in conformity with the reforms of economic planning This institute employs thousands of scientists and a larger number of clerical and other assistants and works out the control figures of the Gosplan which is the actual basis of the annual operational plan and the different five-year plans

The Planning Machinery —The constitution of the planning machinery has undergone very considerable changes as a result of experience As mentioned before, it was at first a body which was subordinate to the Council of Labour and Defence (S T O) and had not direct access to the Cabinet This was not found satisfactory, as having no direct access to the rulers of the State, the recommendations of the Gosplan had very little influence in the national policy In 1935, the organization of the State Planning Commission was completely changed It was now to consist of a Chairman with far wider powers with a commission of 70 members *The chairman was to be one of the two Vice-Presidents of the Cabinet* and this post has been occupied by such high level leaders as Kirov, Kuybishev, and Molotov. The members of the commission were appointed by the Cabinet upon the recommendation of the chairman, were drawn from the leading members of the previous State Planning Commission, from the local planning commissions, from amongst scientists, technicians, agricultural workers—irrespective of their standing in individual departments and institutions. The method of working of the Planning Commission was also thoroughly changed.

The administrative machinery of the Gosplan has gradually grown to be a huge organization employing thousands of scientists, technicians, economists, financial and other experts, and corresponding number of clerical staff It should be remembered that Planning is not the monopoly of the Gosplan, but every one of the eleven autonomous republics, and other autonomous (corresponding to our provinces and feudatory States) units have their own Gosplans (State Planning Commission), besides each commissariat (corresponding to our Ministries) have their own Planning sections. The U.S S R. Gosplan is at the apex of this pyramid of Gosplans and planning sections, and therefore their functions are of two types expressed in two types of departments set up*

A *Departments of Co-ordinative Planning*

(1) Department of the co-ordination of production.
  (a) Section of production economics,
  (b) Section of production technique.

(2) Department of capital works
  (a) Section of capital works co-ordination plan,
  (b) Section of the building industry and architecture,
  (c) Section of hydraulic engineering

(3) Department of district planning
  (a) Section of natural resources,
  (b) Section of the Central Industrial and Western districts,
  (c) Section of the Southern districts,
  (d) Section of the Volga districts,
  (e) Section of the Eastern districts,
  (f) Section of the East Siberian and Far-Eastern regions,
  (g) Section of the Transcaucasian, Uzbek, Turkmenian and Tadjik S S R s and the Kirghiz and Kara Kalpak S S R,
  (h) Section of the Northern districts

(4) Department of material balances
  (a) Section of the co-ordination of material balances,

* In the recent discussion on the future constitution of India, speaker after speaker have referred to the constitution of U S A, England and France as if the constitutions of these countries are the last word on constitution-making But we have not so far come across a single reference to that of Soviet Russia But it appears to us that Soviet Russia with its multitude of nations, languages, religions, and wide difference of culture between different ethnic units offers the nearest paralled to India The problems of Russia and the way they have been successfully tackled by the Bolsheviks are therefore worthy of serious attention from Indian constitution-makers We may point out some analogies Block A of the Cabinet Mission very nearly corresponds to Great Russia, Block B to Ukraine, Block C to the Caucasian Republics and the other autonomous republics correspond to Indian States. To Stalin was assigned the task of reconciling the interests, the passions and feelings of the racial minorities vis-a-vis those of the Great Russians, the dominant nationality As people's commissar for minorities, he had to devote four years to this task, and the singular success he achieved in uniting different interests, and merging all the territorial units into the U. S. S R. forms one of his crowning early achievements.

(b) Section of the balances and plans for the allocation of metals and alloys,
(c) Branch of timber balances and allocation plans for timber;
(d) Branch of building materials balances and allocation plans
(5) Department of financial plan
(a) Section of financial policy,
(b) Section of budget and credit,
(c) Branch of national income

B *Departments of Branch Planning*

(1) Department of fuel and power
(a) Section of fuel balance and fuel supply planning,
(b) Section of coal industry,
(c) Section of oil industry,
(d) Section of local fuel,
(e) Section of electrification
(2) Department of mines and metallurgy
(a) Section of heavy metallurgy,
(b) Section of non-ferrous metals,
(c) Section of rare metals,
(d) Section of non-ore minerals
(3) Department of engineering industry
(a) Section of rolling stock building,
(b) Section of electrical engineering,
(c) Section of general machine-building,
(d) Section of heavy machine-building,
(e) Section of agricultural machine-building,
(f) Section of equipment balances and distribution
(4) Department of chemical industry (Three sections).
(5) Department of timber industry (Two sections)
(6) Department of light industry (Three sections)
(7) Department of food industry (Three sections).
(8) Department of local industries and industrial co-operatives.
(9) Department of agriculture (Six sections)
(10) Department of railway transport (Three sections).
(11) Department of water transport (Two sections)
(12) Department of trade (Two sections)
(13) Department of foreign trade
(a) Section of import plan,
(b) Section of export plan.
(14) Department of culture.
(a) Section of education,
(b) Branch of arts;
(c) Branch of the press.
(15) Department of housing and municipal services.

C. *Independent sections*

Section of defence.
Section of labour and cadres.
Section of road and air transport.
Section of communication plans (post, telegraph, etc).
Section of health services
Section of training of planning personnel *

Moreover, the following institutions are part of the Gosplan: (1) The Central Administration of Economic Accounting of the U S S R Gosplan, and (2) The Institute of Economic Research of the U S S R Gosplan and the All-Union Academy of Planning

The mere list of sections and departments of the Gosplan show the vastness of the organization

What is the position of the Planning Commission vis-a-vis the different ministries (commissariats, the provincial governments, regional authorities, heads of industries and agricultural farms)?

THE GOSPLAN PLAYS THE PART OF ARCHITECT

It should be emphasised once further that the activities of the State Planning Commission are confined solely to the planning and supervision, not to the execution of the plan Its function is similar to that of an architect in the construction of an edifice As is well known, the architect obtains from the employer an idea of the building which he wants to be constructed, and prepares a plan in constant consultation with him But he never undertakes the actual construction of the plan On the other hand, he works out the amount of materials needed, in brick, cement, iron and other things, works out their cost and calls out tenders, but the task of actual construction is given to some firm of engineering contractors During the period of construction, it is the duty of the architect to supervise that the construction has been carried out according to his plan and when the contractor submits his bill, he has to check the bill and certify that it is correct and the building has been constructed according to approved plans The mistake in the theory of working of the late department of Planning and Development was to invest it with powers of execution which, if carried into practice, would have made it a sort of super-department This attitude brought the Department of Planning and Development into conflict

* For details see *Bull. Financ and Econ Leg* No 11, 1935 In 1937 this structure of the U S S R Gosplan underwent certain modifications The department of co-ordination of production was reorganized into the department of the combined plan with the following sections general plan, labour, industrial production, cost price and plan fulfilment supervision. The section of labour and cadres was abolished Instead, a branch for planned training of cadres was included in the department of culture The Institute of Economic Research was also abolished and the Technico-Economic Bureau of the Chairman of the Gosplan was organized in its stead. The section of Defence was reorganized into the department of Defence with three sections: armament industries plan, mobilization preparedness of the national economy, and plan of the P Commissariats of Defence and of the Interior The organization of the department of fuel and power was likewise modified. (For details see *Bull Financ, and Econ. Leg* No. 28, 1937.)

with every other department and ultimately to its suppression But a State planning commission, with functions and organization similar to the Russian Gosplan can render immense good to the country, provided it is staffed with the proper kind of personnel, but not with dilettante politicians, service-hunters, and pseudo-scientists

The State Planning Commission of Russia follows the same philosophy It obtains from every ministry (ministries in Soviet Russia include all branches of human activity) and other organizations like academies, regional authorities, a statement of their requirements worked out in plans The plans from all these ministries and States and from the provincial Gosplans are examined by the various bodies of the Central Planning Commission, who have the task of coordinating them and working them out into a definite programme with the aid of the Central Administration of Economic Accounting. In this way they work out control figures out of the statistics so supplied

On the basis of 'the control figures', the U S S R. Gosplan works out quarterly, annual and five year plans, in exact figures. These are then taken by the President for discussion to Sovnarkom and approved by that body which is the Supreme Cabinet and decrees, orders and directives are issued to provinces, departments of the U S S R and the autonomous republics to carry out tasks assigned to them

Of the plans made by the U S S R Gosplan, the five year plans have acquired justified celebrity but they require a separate article for discussion

SUPERVISION OF THE FULFILMENT OF THE PLAN

This is a very important item in the list of tasks assigned to the Gosplan The object is defined by the author as follows:

"The possibility of supervising the fulfilment of the plan is, in our opinion, a fundamental pre-requisite of planning This supervision should pursue a twofold purpose: to control the fulfilment of planned tasks and to control the development of the national economy The former entails the enforcement of government decisions, the detection of failures to fulfil the plan and the penalizing of such failure The latter entails studying how the plan fits in with actual conditions and what causes the actual course of events to depart from the planned course, it also means devising suitable measures either to alter the plan (in the case of planning mistakes or the impossibility of carrying out the planned tasks under the given circumstances) or to take steps for achieving the planned tasks However thorough the elaboration of the plan, it is always possible that its authors may have overlooked some circumstances, or the data and the notions which they had in mind did not exactly conform with the facts. The execution of the plan may meet with unforeseen or inadequately appreciated obstacles or with human failings such as slackness, dishonesty or ill-will among those responsible for putting the plan into effect. The supervision of plan fulfilment must call attention to the departures from the plan and suggest alterations to be made in the interdependent parts of the plan".

The task of performing this function, though realized by the Government, was not at first assigned to the Central Gosplan but was assigned to various other bodies as the 'Fulfilment Commission, Soviet Control Commission', etc, which were independent of the Gosplan. This practice was found unsatisfactory, and in 1938, when the results of second F.Y P were being analysed and scrutinized it was found necessary to assign this all-important function to the Gosplan itself. The Statutes were:

(1) Submit to the Sovnarkom U S S R its conclusions on the prospective, annual and quarterly plans drawn up by the P Commissariats and other departments of the U S S R and the allied republics Moreover, the economic plan of the U S. S R Gosplan must first and foremost ensure a proper correlation in the development of the various branches of the national economy and elaborate measures to prevent disproportions in their development

(2) In order to obviate possible breaches in the fulfilment of the economic plan, the Gosplan was to

(a) Verify the fulfilment of the State plan by the P Commissariats, departments and enterprises,

(b) Lay before the Sovnarkom U S S R problems and proposals arising from the verification of the fulfilment of the economic plan

(3) To carry out the above tasks, apartment from its central machinery, the Gosplan was to have its commissioners for supervising the fulfilment of the economic plans in republics, regions and provinces The Gosplan's commissioners were appointed and recalled by the Sovnarkom S S S R on the recommendation of the Chairman of the Gosplan, they worked on the latter's instruction and were subordinated not to republican, regional and provincial planning commissions, but directly to the U S S R Gosplan

The Gosplan had the right to demand from the P. Commissariats and other departments all necessary data and explanations necessary for the supervision of the fulfilment of the country's economic plan, similar rights were granted to Gosplan commissioners in republics, regions and provinces in regard to enterprises and economic institutions.

In this way Gosplan commissioners were made responsible for plan fulfilment supervision and placed in a position to exercise it on the spot.

(4) The planning commissions attached to the Sovnarkoms of allied republics and to regional and provincial executive committees were to follow the instructions of the U S S R. Gosplan in matters connected with both methods of planning and plan fulfilment supervision.*

How would our administrators, Viceroys and Governors, H. M's provincial ministers and the lesser bureaucrats and the political leaders like the idea of assigning such a task to the Government Machinery

* For details see 'Statute of the State Planning Commission of the Sovnarkom U. S. S. R.', *Bull. Finac. and Econ. Leg.* Nos 3-4, 1938.

of Planning? It would have to perform a very unpleasant, but nevertheless an all-important task, for have we not, in this country, been accustomed to catching slogans uttered in season and out of season by political leaders and administrators, and have allowed ourselves to be bewitched by them The slogans have grown into dangerous superstitions, and threaten to engulf us A periodic self-examination of themselves and of their slogans, by administrators and political leaders, would be of the greatest benefit to the country

Now, what is the difference between Soviet Planning and the Planning which is carried out in other countries? This is expressed in the words of Stalin as follows ·

> 'Admittedly they (i.e under the capitalistic system) too have something akin to plans But these plans are prognosis, guess-plans which bind nobody, and on the basis of which it is impossib'e to direct a country's economy Things are different with us Our plans are not prognosis, guess-plans, but *instructions* which are *compulsory* for all managements and which determine the future course of the economic development of our *entire* country You see that this implies a difference of principle'

M N S.

GEOLOGICAL FACTORS IN THE INTERPRETATION OF INDIAN GRAVITY DATA

P EVANS AND W CROMPTON

INTRODUCTION

DURING the years 1938 and 1939 the Burmah Oil Company and its associates carried out a geophysical survey of a large part of Northern India and Burma An account of the methods employed was given at the symposium on 'Mineral Research in India for developing Mineral Industries' held by the National Institute of Sciences in Delhi in November 1945. Although the war led to the temporary suspension of the survey, it has been possible to tackle some of the problems of interpretation Some of the methods of interpretation of the gravity data, which appear not to have been used before, were the subject of a discussion at the Geological Society of London on January 16, 1946 when the present authors gave a resumé of the principal points of their paper 'Geological Factors in Gravity Interpretation illustrated by evidence from India and Burma' The paper has recently appeared in the *Quarterly Journal of the Geological Society*,* and SCIENCE AND CULTURE is indebted to the Council of the Geological Society for permission to summarize and quote from the paper and to use some of the illustrations

No account of this geophysical work can omit a reference to the great amount of assistance received from the Survey of India (especially the Surveyor General, and from Brigadier Glennie, Brigadier Bomford, and Mr Gulatee) and the Geological Survey of India, or to the help received from colleagues and friends in the Burmah Oil Company and associated companies and from Dr E. C Bullard

The subject may conveniently be divided into the following parts —

1 Geographical and Geological Background
2 Geophysical Background
3 Effects of Thick Sediments on Gravity Readings
4 The Results obtained in India and Burma
5 Conclusions

GEOGRAPHICAL AND GEOLOGICAL BACKGROUND

The area discussed includes most of Bengal, Assam, and Burma In the extreme north lie the Eastern Himalayas with the Assam Valley (Brahmaputra Valley) to the south On the south of the Brahmaputra come the ranges of the Assam-Burma frontier reaching 12,000 feet, these continue southwards to the Arakan Yoma Further west on the southern side of the Brahmaputra Valley is the Shillong Plateau, 6,000 feet, south of which is another alluvial valley, the Surma Valley, and beyond that again more hills, lower than the others mentioned, but rising range beyond range to merge into the Arakan Yoma

On the other side of the Arakan Yoma comes the great central valley of Burma In the north the Chindwin and the Irrawaddy are separated by considerable hills, but southwards the valley becomes broad rolling country with the Arakan Yoma on the west and the Shan Plateau on the east

For present purposes little need be said about the oldest rocks; they occupy part of the Himalayas, the Shillong Plateau, the mountains at the head of

* Q. J. Geol. Soc., vol. cii, p. 211 (1946).

the Assam Valley, the Shan Plateau, and possibly the core of the Arakan Yoma (fig 1) Our main interest lies in the sedimentary formations* known to geologists as Cretaceous and Tertiary, beds of sand and clay that were deposited in shallow seas and tinuing northwards into Assam, whilst its eastern shore-line lay to the east of the Arakan Yoma. The gulf received many rivers, especially from the embryo Himalayas, and these rivers brought down vast quantities of sediments which were deposited on the sea-

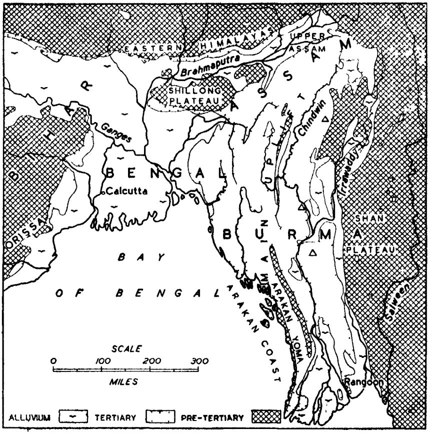


FIG 1 Outline geological map of North-East India and Burma

deltas during a period reaching back for nearly a hundred million years Throughout much of this time a large part of Bengal, Assam and Burma was under the sea There seems to have been a gulf which had its western shore-line somewhere near the present western shore of the Bay of Bengal but continuing floor This shallow sea, the precursor of the present Bay of Bengal, fluctuated considerably—in the early Tertiary times there was a general tendency towards expansion of the sea, especially in the east, *i.e.*, in Burma. Then came a rapid retreat, and most of the sea-bed became dry land, only to be submerged again in that part of the Tertiary known as Miocene—some thirty million years ago The waters crept north-westwards and north-eastwards in Assam and eastwards in Burma until seas and large estuaries extended even further than before, covering most of Assam and almost all Burma as far east as the edge of the Shan Plateau. With this invasion by the sea there was renewed deposition of sediments. In a general way open seas occupied southern Burma with a transition to brackish water and estuarine conditions in the north of Burma and in Assam.

* The principal geological formations with which we are here concerned, arranged with the newest at the top of the list, are :—

Recent alluvial deposits

Tertiary { Pliocene, Miocene, Oligocene, Eocene }

Mesozoic, of which the Cretaceous is the newest member
Palaeozoic
Pre-Cambrian

In **figure one** all formations older than Tertiary are grouped together for the sake of simplicity

Well on in Miocene times there was a second break in the sedimentation, the sea-floor was uplifted and in places suffered appreciable flexuring. The depression which followed did not bring in extensive areas of sea, and the later deposits were for the most part laid down in deltas, lakes, and river valleys. These included the sands with fossil palm-trees which are found in the Irrawaddy Valley of Burma, and many bands of conglomerate and beds of mottled clay. Altogether, in the areas of greatest deposition, over 50,000 feet of sediments were laid down, and this implies that during Tertiary times the sea-floor must have subsided by this amount in

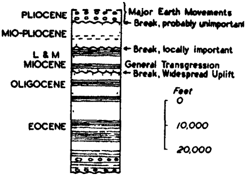


FIG 2 Succession of Tertiary sediments in Assam and Burma

order to keep pace with the constant inflow of sediments. Finally there were the great movements of the earth's crust associated with the latest phases of the building of the Himalayan mountain ranges, and these movements brought about the uplift, buckling, and breaking of this great series of sediments, now largely consolidated into hard sandstones, shales, conglomerates, limestones, etc (fig 2)

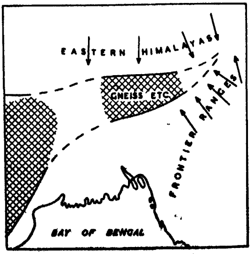


FIG 3. Overthrusting against the North-Eastern part of the Indian Shield.

It is worth while to pay a little attention to the way in which these formations were affected by the earth-movements. During past ages the Indian Peninsula has been a relatively stable area (the Indian Shield) whilst the region round about has suffered intense deformation during earth-movements. Jutting out north-eastwards into Assam is a piece of ground which, geologically speaking, is a piece of the Peninsula, and this has been but slightly influenced by the changes which profoundly modified the adjacent areas. From the north the Himalayan country has pressed southwards against this stable block, whilst from the south-east the sediments of the Assam-Burma frontier ranges have been pushed north-westwards (fig 3). Along lines extending for scores of miles there are great 'faults' along which slices of country have been driven forward and piled up in a way which is illustrated diagrammatically in figure 4. Such areas of 'over-thrusting' occur along

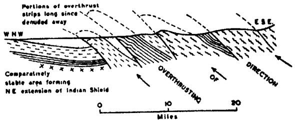


FIG 4 Diagrammatic section of overthrusting

the southern edge of the Himalayas and in what geologists have termed the Belt of Schuppen of the frontier ranges. This latter belt merges into an extensive region in which the sediments have been folded in the manner shown in figure 5. This

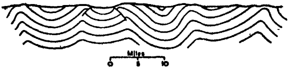


FIG 5 Diagrammatic section of folded sediments.

region occupies the southern part of Assam, the eastern part of Bengal, and the Arakan coast of Burma. On its eastern side lies the main uplift, where the older rocks come to the surface; this roughly coincides with the general line of the Arakan Yoma (fig. 6) Beyond this, again to the east, comes the big Chindwin-Irrawaddy basin, where the folds run nearly north and south. A cross-section, necessarily much generalized, is shown in figure 7. Yet further east comes the Shan Plateau which was not greatly affected by the Tertiary folding

The age of these earth-movements is easily settled; there is little evidence of flexuring until the second emergence from the sea referred to above, and the principal folding and faulting is later than deposits of the late Tertiary age known as Pliocene. modified later by intense denudation by rain and rivers

Besides the folded and faulted sediments which make up most of the area of Tertiary rocks, there are volcanic rocks found along a line extending south-

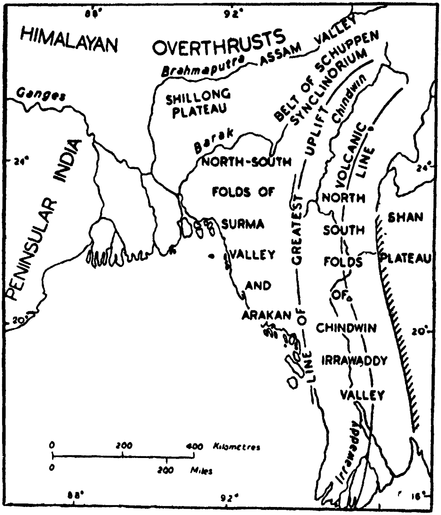


FIG 6 Main structural regions of Assam and Burma

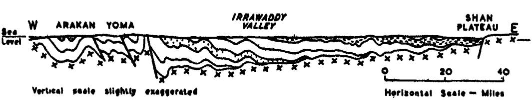


FIG 7 Diagrammatic cross-section through Burma.

These earth-movements led to the formation of great inequalities in the surface which were rapidly lessened by denudation; the hills and mountains of today are the result of this uplifting and folding profoundly wards from the extinct volcano of Taungthonlon* through the many craters near Monywa to the

* The northernmost triangle on figure 1

prominent cone of Popa and thence by way of some dolerites east of Thaye'myo to the lava cone of Narcondam and the still active volcano on Barren Island.

GEOPHYSICAL BACKGROUND

Before going on to discuss the gravity observations made in the region whose geology has been briefly outlined, it is desirable to sketch in very lightly the general geophysical background against which the evidence should be reviewed The subsequent discussion will not be concerned with the bearing of the evidence on local structural problems, but with its application to some fundamental principles of Indian geology and geodesy

Units The unit in which gravity is measured has recently been given the name 'gal' from Galileo, and gravity, usually referred to as g, is about 980 gals. This unit is too large for detailed investigations and in gravity surveys it is convenient to use the milligal, a thousandth part of a gal, and so roughly a millionth part of gravity

The instruments used in geophysical surveys measure to a tenth part of a milligal—and so detect a variation of one part in ten million The actual gravity changes we shall be considering are from a few milligals up to one or two hundred milligals As an illustration of the magnitude of a milligal, we might mention that an extensive sheet of rock of average density and 30 feet thick would produce a gravitational attraction of about a milligal

Anomalies Gravity varies from 978 at the equator to 983 at the poles, and is greater at sea-level than on a hill Various formulae have been

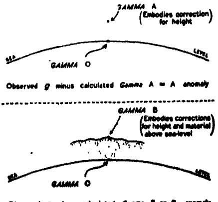


FIG. 8 A and B anomalies.

devised to connect gravity (at sea-level) with latitude, and so give the normal value of gravity at any point. This standard may be called gamma nought. The actual observed value of gravity usually differs from the normal, and it is this observed value which we denote by g Any difference there may be between g and gamma nought is the gravity 'anomaly'. Obviously if the station is not at sea-level we must allow for the height, as gravity gets less when we get away from the earth's surface, and this correction applied to gamma nought gives gamma A The difference between observed g and gamma A is accordingly called the A anomaly (fig 8) But merely taking height into account would be satisfactory only if the observations were being made in a balloon, whereas the station is on the surface of the earth ; consequently besides allowing for the height we also have to allow for the attraction of the material between sea-level and the observation station, and so we have gamma B, and g minus gamma B will be the B anomaly The correction for height and the correction for the ground around the station are the two most obvious ones, but all sorts of other corrections can be devised and successive theoretical corrections have been applied by the Survey of India until there is even an F anomaly The anomalies, it seems, have become alphabetically minded and have started to compete with the vitamins We must ourselves plead guilty to suggesting as a matter of convenience two more, the G and H anomalies.

Isostasy India is the home of isostasy Nearly a century ago there was much discussion about the anomalous gravity readings of Northern India. The plumb-line, one would expect, should be attracted towards the mountains—actually it is deflected away from them (fig 9) In 1855 Airy put forward the

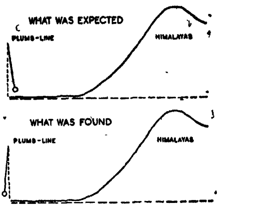


FIG. 9 Deviation of the plumb-line near the Himalayas.

hypothesis that the visible crust is supported on a denser layer and that any excess of mass protruding as mountains above the general surface is balanced by abnormally light material below. That is, beneath the mountains are light 'roots' sticking down into the heavy layer, and the higher the mountains, the

bigger will be the roots (fig. 10) This defect of mass beneath the mountains explained the anomalous plumb-line and gravity readings immediately south of the mountain range

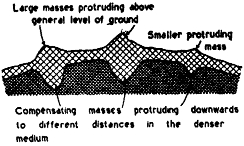


FIG 10 Diagram of Airy's hypothesis

A few years later a rival hypothesis appeared Pratt supposed that the upper layer of the earth's crust had originally been of uniform density and thickness, the earth's surface having been a perfect spheroid As the crust thickened there were contractions and expansions, mountains being formed where the crust had expanded most (fig 11) The

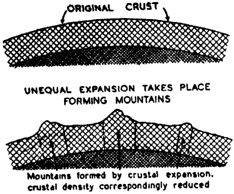


FIG 11 Diagram of Pratt's hypothesis

expansion in volume, he said, must of course be accompanied by a reduction in density, so beneath each large mountain range the crust *must* be much lighter than average, and below each hill range the crust *must* be slightly lighter than average

The geologists of Pratt's day did not imagine that mountains had been formed simply by expansion of the earth's crust as supposed in his hypothesis, but there seems to have been little consultation between mathematicians and geologists, and the complete absence of any real basis for Pratt's hypothesis passed unnoticed. Airy's more reasonable hypothesis received no support from the geodesists and most elaborate and time-consuming calculations have been carried out, especially by Hayford and Bowie, on the basis of Pratt's hypothesis.

This idea of the excess of mass at the surface being nicely balanced by a defect of mass beneath the surface is generally known as isostasy. There has been much discussion of the degree of which this balance is attained, and an enormous volume of data has been gathered The low-density material beneath the mountains is referred to as the 'compensating mass' or the compensation, and its amount can be calculated in accordance with the Pratt-Hayford-Bowie hypothesis supposing the compensating mass to extend downwards to some depth such as about 100 kilometres (fig 12). It is obviously absurd to

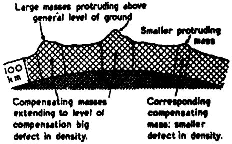


FIG 12 Compensation according to the Pratt-Hayford-Bowie system of isostatic correction

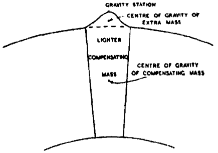
assume that the earth's crust is made up of a set of vertical columns each one of uniform density throughout, each differing in density from its neighbours, and each having its density exactly related to the present-day relief of the surface, yet this is the basis of the calculation

What then about isostasy? The condemnation of Pratt's hypothesis does not necessarily rule out the possibility of isostatic compensation reached *in some other fashion* The conception of isostasy may perhaps be summarized by saying that the gravity anomalies and some other evidence show that the lighter uppermost layer of the crust behaves somewhat as if it were floating in the denser sub-stratum The mountains are an extra load on the surface and are buoyed up by additional lighter material below

The general idea of isostasy is one of great importance but we believe that from the beginning the hypothesis fell into the wrong hands It should have been studied by geologists, but instead it was developed by mathematicians who seem not to have been concerned whether their postulates bore any relation to what was geologically possible We don't know whether to blame the immaturity of geology, or whether it simply was that the mathematicians and the geologists were talking different languages. The upshot was that isostasy which should have been the hand-maiden of the geologist was abducted by the mathematician. The hypothesis took the wrong turning and has been in trouble ever since.

For many years past one of the chief aims of the geodesist has been to find out how far the gravity observations agree with the hypothesis that the crust is in isostatic equilibrium. Elaborate calculations have been made, using tables based on the Pratt hypothesis and assuming that compensation is complete at a depth of 113·7 kilometres These assumptions have no doubt provided a means of making what is at best a cumbersome calculation, but their arbitrary and totally unreal nature is usually lost sight of

How are these calculations made? If the crust is in isostatic balance, the extra load at the surface is just offset by the lighter material below, but the extra load and its compensation are at different distances from the observing station and so there results a gravity anomaly, as will be seen from figure 13 If isostasy obtains, it should be possible



Although extra mass at surface is compensated by defect of mass beneath there remains an anomaly because the centres of gravity are at different distances from the station Hayford's correction is intended to allow for this

FIG 13 Application of Hayford's correction

by calculating an appropriate correction to get rid of the anomaly For example, at Darjeeling —

Calculation shows that gamma nought is .. .	979 098
Correction for height and underlying material shows gamma B to be	978 655
Whilst observed gravity is .	978·501

There is a discrepancy between gamma B and the observed gravity amounting to 154 milligals, that is to say the B anomaly is minus 154 milligals In other words, there is a large discrepancy between observed and calculated gravity If we assume that this is due to 'compensation' according to the Pratt-Hayford hypothesis, calculation can be made to find a correction for the compensation. This calculation gives a correction of 186 milligals making

gamma C=978·469

which is much nearer the observed value of 978·501, the discrepancy (C anomaly) being only plus 32 milligals. In this instance there is a very considerable reduction in the anomaly. In some cases the anomaly almost disappears, but in others, the anomaly, so far from being reduced, is actually increased

The method of calculating compensation can be varied and it has sometimes been tacitly assumed that the method which gives the least average anomaly is the best—thereby begging the question Over large areas the C anomalies are indeed small, amounting to only a few milligals, but in parts of India and the Netherlands East Indies they amount to a hundred milligals or even much more

The corrections to be applied to allow for compensation range from a few milligals to 50 or even 100 or more At Darjeeling the correction is exceptionally large

THE EFFECTS OF THICK SEDIMENTS ON GRAVITY READINGS

The main thesis of the paper presented to the Geological Society of London was that in all these elaborate geodetic calculations the effects of sediments (which have a density below the average of other rocks) have been ignored, so that where sediments are thick the geodetic calculations need modification Our investigations of the literature of gravity work failed to reveal an instance in which geodesists had taken into account the effects of relatively light sediments at the surface All calculations have been based on a standard density of usually 2 67, and where sediments are thick, the difference between the *real* density of the sediments (about 2 2 to 2 5) and the *standard* density of 2 67 assumed in the computations makes a difference of 50, 60, 70, or even 80 milligals We put forward the view that because geodesy has been to such a large extent divorced from geology, this important factor has been neglected, and geodetic calculations are wrong wherever there are thick sediments

Fifty years ago the geologist G K Gilbert considered the possibility of making allowance for sediments of less than average density but did not pursue the subject. Various later writers suggested that negative anomalies which remain after applying the isostatic correction could perhaps be attributed to the presence of light sediments. In 1924 David White, then President of the Geological Society of America, pointed out that geodesists had not taken into account the presence of rocks of excessive or deficient density which may greatly affect the local value of gravity. He recommended that 'study of the gravity anomalies with reference to the local

geology should precede the discussion of isostatic equilibrium'

White's appeal for computation of the effects of the known structures near the gravity stations met with little response ; he himself admitted that 'the task is difficult and time-consuming beyond expectation or even belief', and this probably explains the continued neglect of this important branch of geophysics References to the connection between negative C anomalies and areas of sedimentation continued on a somewhat vague and non-quantitative basis R T. Chamberlin made some trials allowing for geology down to 8½ kilometres, but he concluded that his method of working was not satisfactory and echoed White's reference to the labour of computation. So when we decided to attempt to calculate the gravity corrections for the sediments at several hundred stations, it was necessary to devise some comparatively rapid means of computation

We were fortunate in having the help of Brigadier Glennie (who had himself discussed the subject) and Mr Gulatee They proposed a calculating chart which we adopted in a simplified form and referred to as a template Our procedure was to draw on copies of this template two cross-sections (fig 14)

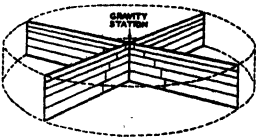


FIG. 14 Arrangement of cross-sections through gravity station

through each station showing the geology down to a depth of about seven miles The separate compartments of the template (shown in detail in figure 15) were so arranged that each one produces a gravity anomaly of one milligal when occupied by material with a density differing from the average by 0 1.

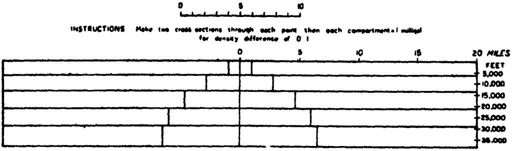


FIG 15 'Template' for estimating geological corrections

As this was (we believe) a previously untried scheme, we made several preliminary tests We took a pair of stations which were situated one on the crest of an upfold and one in the adjacent trough, as shown in figure 16 The amplitude of the folding

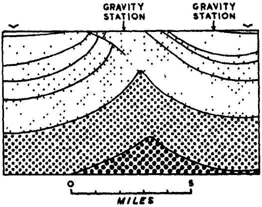


FIG 16 Two stations used as a preliminary test

was known to be about 16,000 feet, and the geology was sufficiently well known to make it possible to calculate the effects on gravity of the geological structures at each of these stations , the difference was 23 milligals. The same test was applied to another pair of stations situated on a crest and an adjacent trough where the difference was somewhat less. In each case the calculated difference agreed with the observed difference, so we were encouraged to go ahead.

We were aware of several possible criticisms · Was it justifiable to attempt correction to 11½ kilometers? What was the accuracy of the section drawing? Were two sections per station enough? Did we know the densities of rocks at great depths?

Since in parts of Assam and Burma sediments extend down to 10 or even 15 kilometres we had to

take the sections down to great depths Obviously we cannot know much about the structure at these great depths, but errors there have less importance than those near the surface, and in any case densities are probably not far from the 'standard' density

Next, are the sections accurate near the surface? This depends on the geological evidence available; many sections are sufficiently accurate, some are not, and the computations for these are only approximate

Again, are two sections enough to give a correct answer? We tried four sections and found only a slight gain in apparent accuracy, less than the errors inherent in the nature of the material

The most potent criticism is that the whole calculation depends on the accuracy with which the densities are known Gravity calculations employ an average density of 2 67, and the proposed corrections depend on variations from this figure A small error in the density assigned to some of the sediments may mean a large error in the calculated correction to be applied Here we must admit that we are in difficult territory, and it was this doubt about densities that gave special importance to our first two checks We believe that the values assigned to the densities have been supported by these check results and by the reasonable nature of the final picture

Much time was spent on an exhaustive search of the literature dealing with densities of buried rocks Meantime measurements were being made in India of near-surface samples and samples from core-holes and wells The inquiry showed how many uncertainties there are.

The effect of *temperature* on rocks devoid of water is small, but the critical temperature of water is reached at a depth of some thirty or forty thousand feet, and the expansion of water in the interstices of porous permeable rocks must be appreciable *Pressure* effects are uncertain, but it is probable that surface samples of rocks that have been deeply buried provide some indication of the effects of high pressures The proportion of *interstices* and the degree to which they are filled with water are the main factors influencing density Opinions vary from assuming that saturation decreases with depth to assuming the interstices to be completely filled We have taken the latter view as more nearly correct Fortunately the deeper sediments in the area dealt with contain only a small proportion of the more porous rocks

From the laboratory determinations and in the light of the views of the authors consulted, we chose a set of densities which may be summarized —

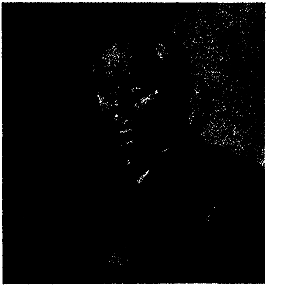
	Within 5,000 feet of the surface	Deeper than 5,000 feet
Alluvium	2 0	2 1
Upper Tertiaries	2 1 to 2 45	2 2 to 2 55
Lower Tertiaries and Cretaceous	2 5 to 2 55	2 55 to 2 6
Older Rocks	2 67	2 67

(*to be concluded*)

SIR JAMES JEANS (1877—1946)

THE death of Sir James Hopwood Jeans removes a great astronomical celebrity not only of England but of the whole world of the present age In cosmology his name ranks with such masters as Laplace, Poincaré, Darwin, and Liapounoff. There is hardly a topic connected with non-relativistic cosmology which has not been touched by Jeans, and the modern scholar always looks up Jeans's work with the confidence that he would get some suggestion, if not a brilliant attempt at a solution, regarding any point which may have cosmological importance Jeans was an applied mathematician par excellence labouring to get a glimpse of the mysteries of the creation (and the creator of his concept was a pure mathematician). His outlook was pre-eminently dynamical, and in this respect he differed from most of his English contemporaries. The period between the last two great wars saw intense activity in theoretical astronomy, both stellar and cosmological. While some of the great leaders of thought in this line discuss the equilibrium aspect of stellar configurations, it is the dynamical aspect of cosmic matter which makes the greatest appeal to Jeans The plan of his work is grand and he executes it in a superb manner. His considerations are not limited to this, or that problem of cosmology but cover the entire field of cosmic matter as yet discovered by astronomy. He works out a scheme with profuse mathematical details and wide generalizations, and with it seeks to explain all phenomena of the sky starting from the breaking up of a primeval cosmic cloud into nebulae, to the formation of stars and stellar groups, and ending in such small details as satellites of planets and asteroids. His analysis is sharp which

cuts through external barriers and directly reaches the heart of the problem The cosmological theories of Jeans may or may not survive, but there is little doubt that his ideas will continue to inspire the workers in this line for a long time to come



Sir James Jeans

Though Jeans was a great interpreter of Newtonian mechanics he was one of the earliest of English mathematicians to appreciate the quantum concept put forward by Planck and Einstein on the Continent The modern atomic theory initiated by Bohr made a great impression on him, and he sought to apply the theory of ionization to the explanation of stellar classification, which, however, is not supported by other astrophysicists He was probably one of the earliest of astronomers to suggest that the stellar energy is of subatomic origin and supplied by what was then expressed as "annihilation" of matter.

James Hopwood Jeans was born at Southport on September 11, 1877. His father William Tullock Jeans was a Parliamentary journalist As a boy Jeans was sent to Merchant Taylor School where he first took the classical side, but when his aptitude for mathematics was discovered he went over to that side. He was educated in the Trinity College, Cambridge and was bracketed second Wrangler in 1898 with J. F. Cameron. He became a Fellow of Trinity in 1901, and subsequently a University lecturer. In 1905 he was called to the chair of Applied Mathematics at Princeton, and was recalled in 1910 to Cambridge as Stokes Lecturer in Mathematics. But he subsequently gave up teaching and devoted himself entirely to research work In 1914 his report on radiation and quantum theory was published, which brought him recognition, and in 1917 he got the Adams Prize by an essay which was later published as "*Problems of Cosmogony and Stellar Dynamics.* Jeans was elected Fellow of the Royal Society in 1906, of which he served as secretary during 1919-29 From 1925 to 1927 he was president of the Royal Astronomical Society, and was awarded the Gold Medal of the Society in 1922 He was knighted in 1928 and was given the Order of Merit in 1939 Jeans came out to India as President of the Silver Jubilee Session of the Indian Science Congress in 1938

The work which first brought Jeans recognition as scientific thinker of originality was his calculation of the formula for energy distribution in enclosed radiation for large wave lengths (strictly speaking wave length × absolute temperature) from the point of view of the electromagnetic and gas-kinetic theory This classical formula, now known as Rayleigh-Jeans formula, was first given by Rayleigh, but it was put on a broader basis by Jeans By a very elegant method Jeans devised a means of counting the number of electromagnetic vibrations in an enclosure lying in a certain frequency interval This was a neat approach by the classical method to the modern quantum mechanical way of calculation in a radiation field Earlier, Jeans gave a rigorous proof of Maxwell's distribution law of velocities among the molecules of a gas with clean assumptions The outcome of his studies in the kinetic theory of matter and statistical mechanics was the publication of *The Dynamical Theory of Gases* with which every student of this subject is familiar

But the most favourite theme of Jeans was cosmology and it is with this subject that his name will ever be associated Coming after Poincaré, Darwin and Liapounoff, he found the subject sticking in a controversy. It was long known that a mass of gravitating liquid can rotate steadily in the form of an oblate spheriod, provided its rotation is not quick As rotation increases and the three axes are as 12 12 . 7 one of the equatorial axes will grow longer than the others, and the rotating mass will take the form of an ellipsoid with three unequal axes known as Jacobi's ellipsoid. If this ellipsoid be free to change its form, then Poincaré found that as rotation increases still further, the Jacobi's ellipsoid lengthens out, and when its axes are as 23 : 10 : 8, is distorted into what is known as a pear-shaped figure Poincaré started work to find if the pear-shaped figures are stable, but left it unfinished. Darwin in course of his cosmological researches took up this problem at this stage, and after very complicated calculations came to the conclusion that the pear-shaped figures are stable. On the other hand, the Polish methematician

Liapounoff published a long memoir in which he claimed to have proved that the pear-shaped figures are unstable. Liapounoff's memoir being in the Russian language was not given the attention it deserved at that time, but the matter was not still regarded as being finally closed. Jeans stepped in at this stage He discarded the complicated methods of his predecessors and by a new and very much simpler method of his own not only proved conclusively that the pear-shaped figures are unstable but was also able to point out where Darwin's result went wrong On following out the development of these figures Jeans came to very important cosmological conclusions As rotation of the liquid mass proceeds, a furrow appears on the surface of the pear-shaped figure near about its middle ; it develops quickly into a narrow waist and the process is finally followed by a cataclysm. The two portions into which the deepening furrow divides the mass are as a result detached from one another This phenomenon is known as *fission*. But when the rotating mass is composed of a gaseous atmosphere round a small nucleus, it takes with increasing rotation a lens-shaped form Soon a stage is reached when the gravitational attraction at the edge is unable to overcome the centrifugal force there, and matter is shed from the equator in a continuous stream This is called *equatorial break up* Jeans's theory of the configurations of rotating gas masses is based on the idea that the original rotating parent mass can break up only in these two ways The spectroscopic binary stars he associates with fission break up of a rotating liquid mass The formation of visual binaries he attributes to a different cause, namely the chance neighbouring condensations of two masses at the time of the birth of stellar systems in the large nebula, and their mutual gravitational action. On the other hand, he was able to show that in a rotating mass of gas of low density, and in which Boyle's law is approximately obeyed, conditions are favourable for an equatorial break up These phenomena, according to Jeans, account for the birth of short period double stars and extragalactic systems.

To Jeans and Jeffreys we owe the complete working of the theory of the formation of the solar system by the tidal forces raised on the surface of the primeval sun by a passing massive star. The idea was originally advanced by Chamberlain and Moulton, but their explanation differed in some important respects from that of Jeans. Jeans' hypothesis is that the massive star tore a linear filament from the body of the sun by means of tidal forces. The filament followed the bigger star to a certain extent but a large part of it, unable to keep pace with the receding bigger body, and also on account of the pull of the sun, was left back. This was owing to its instability, ultimately broken up into planets and asteroids. The theory of Jeans also gives an explanation for the origin of the satellites of the planets by the further breaking up of planets in a similar manner. Jeans believed, as his collision theory suggests, that the planetary systems in the sky must be very rare.

The formation of the extragalactic nebulae Jeans attributed to what he called gravitational instability of a very extended primeval mass of very thin gas He was the first to call attention to this phenomena of gravitational instability A disturbance in the gas mass spreads only in waves of condensations and rarefactions and owing to viscous forces is dissipated as heat The mass gains thermodynamic energy But the gravitational action between distant condensations and rarefactions will cause a decrease in the gravitational energy which will be greater than the previous increase of thermal energy This by decreasing the total energy will produce an instability in the gas which will break up into smaller fragments Such a fragment will represent a consideration which, as Jeans showed can resist dissipation into space if its mass is at least of the order of some millions of solar mass The identification of such condensations of matter with extragalactic nebulae which have generally this mass may be considered as a wonderful success of Jeans' cosmology Jeans invoked the same explanation to account for the birth of the condensations of stellar systems in the outer parts of nebulae. The spiral nebula, according to Jeans, has probably been formed by the ejection of matter at the edge of the lenticular form of a rotating compressible mass of gas about which mention has been made before. According to Jeans, the equality of the gravitational and centrifugal forces was not simultaneously achieved at all points of the edge probably due to asymmetric attractions by neighbouring nebulae, but first only at two diametrically opposite points from where ejection of matter started and continued thereafter But the existence of the spiral arms with generally two convolutions, the most important thing of a spiral nebulla, has not been explained by this theory.

Jeans also studied the problem of the internal constitution of stars by following a path different from Eddington's He came to the conclusion that the deep interiors of stars must be liquid Many of his conclusions regarding stellar structure are not supported by other astronomers But he was one of the earliest to suggest and strongly advocate the view that the energy in stars is of subatomic origin and is supplied by annihilation of matter. Indeed he was even led to believe that the universe is slowly dissolving into radiation and its ultimate end is a heat-death. Jeans' explanation for the periodically fluctuating brightness of cepheid stars is different from the usual one of pulsations. In his opinion, these stars are elongated rotating configurations, and the change in

brightness arises from their vibration and presenting the broader or smaller face towards us. The consensus of opinion, however, is that the theory of pulsation advocated by Eddington better explains the phenomena of these variable stars It is in the field of the internal structure of stars that the speculations of Jeans met with the least support from his contemporary workers

Besides what has been mentioned, Jeans has initiated many new ideas, some of which he has developed with analysis in his characteristic manner His two books, *Theory of Cosmology and Stellar Dynamics*, and *Astronomy and Cosmogony*, are full of original ideas and beautiful mathematical techniques

Any account of Jeans is surely incomplete if we fail to make mention about his books which have so much popularized modern astronomical thought and the theory of atomic structure Many University students in India are familiar with *The Mysterious Universe, The Universe Around Us* and *The New Background of Science* The impression which the general public gets after reading his popular books is that the author is not only a mathematician but is also a philosopher That Jeans was led by his study of nature to a philosophical frame of mind cannot be doubted

N R Sen

NOBEL PRIZE IN MEDICINE AND PHYSIOLOGY

PROF H. J MULLER, one of the founders of Modern Genetics, has been awarded the Nobel Prize for Physiology and Medicine for 1946 This recognition by the Nobel Committee will not put him higher in the estimation of those who are acquainted with Professor Muller's brilliant contributions to Genetics, but surely it will serve to indicate to the non-geneticists his rightful place amongst the first rate scientists of the world ; more so because up till now he has not been rewarded even with a proper position in life befitting his wonderful scientific achievements.

Prof Muller was born in 1890 and was educated at the Columbia University His researches in Genetics started here in 1911. One of his very early contributions, the discovery of the property of Genetic Interference, is one of the very basis on which the theory of crossing over is built He became the Professor of Zoology in the University of Texas in 1925 and in 1927 came out with his epoch making discovery of the efficacy of X-rays in the production of mutation in *Drosophila* sperms which revolutionized the methods of approach to fundamental problems regarding the nature of the gene itself Progress in this virgin field was bound to be rapid and today hardly a genetical laboratory, worth the name, exists in the world where radiation genetics is not studied To keep pace with the progress of such rapidly expanding subject is difficult enough but to be able to claim a lion's share in the exploits of this branch requires the ability of a man like Muller, and he is, therefore, a class by himself He left Texas for Moscow as a senior geneticist in 1938 and built up a brilliant school of *Drosophila* geneticist in U S S.R He joined the Edinburgh Institute of Animal Geneticist as a guest of the Edinburgh University It is here, the writer of this note had the rare opportunity to know Professor Muller both as a teacher and an active research worker.

The arrival of this little man in Edinburgh with a large packing case full of synthetic stocks of *Drosophila*, changed the whole atmosphere of the Institute Workers of the Institute began to gather around him daily to listen to his illuminating discourses about the status of the various problems of radiation genetics and how they could be tackled and solved Very soon the whole batch of *Drosophila* workers of the Institute started a sort of team-work inspired and guided by one of the ablest geneticists of the world. He kept himself busy not only guiding research but also in carrying on planning and conducting experiments for 10 to 12 hours daily and for 365 days in the year. Herein perhaps lies the secret of his phenomenal success.

Professor Muller is now back in America and is only 57 years old. The world hopes that he shall have many more years of fruitful research and shall remain as a constant source of inspiration and guidance to his colleagues and co-workers.

S. P. R. C

THE ROLE OF ANIMALS AND PLANTS IN HISTORY

A C JOSHI,

PROFESSOR OF BOTANY, GOVERNMENT COLLEGE, LAHORE

THE average man of today, dwelling in the city or a town, is likely to regard himself as a being wholly apart from the rest of the living world There is, however, hardly any truth in such a conception Like all other organisms, man too is a creature of his environment and feels the force and the moulding effect of his surroundings This environment comprises the physical features of the land and climate on the one hand, and its fauna and flora on the other From the last two, man obtains his food. This was so in the Old Stone Age, when the primitive human beings wandered in jungles in search of fruits, seeds, roots, fish or eggs, or hunted larger beasts It is so even today that man has mastered the steel and machinery

No factors exercise a greater influence on the development of a living organism than the sources of his food supply An adequate food supply is, and always has been, man's most outstanding need It is an urgent as well as a recurrent need of all individuals as also of the human society, and has affected the activities of man in relation to the land at every stage of economic development It determined, before the establishment of the present international trade, the locality of the encampment or village, the size of the territory from which sustenance was drawn, the population a given piece of land could support, and the length of residence at one place

In addition to food, man has depended for a long time on plants and animals for shelter, clothing and fuel Modern civilization has increased his wants still further He needs many other commodities, the raw materials for the manufacture of which in many cases are obtained from plants and animals, *e.g.*, drugs, oils, rubber, resins, gums, hides, etc. The maintenance of an adequate supply of these raw materials for the use of the industry is essential to the existence and prosperity of any nation Thus the distribution of plants and animals exercises profound influence on the economic and social life of the nations of the world, affecting domestic conditions as well as international relations, and even changing the course of history

The Influence of Different Fauna and Flora on the Development of Civilization

The very different fauna and flora of the several continents greatly influenced their advance towards civilization. The large grasslands of the world became historically significant only where mammals capable of domestication were present In Australia, the lack of a single indigenous mammal fit for domestication and of all cereals prevented from the very beginning the pastoral and agricultural development of its native population Hence when it was discovered by the Europeans in the 16th Century, Australia presented the unique spectacle of a large continent with all its inhabitants still at the stage of food gatherers and hunters On the other hand, Europe, Asia and Africa had an abundant supply of indigenous animals fit for domestication, and especially those fitted for nomadic life, as for example, the camel, horse, ass, cow, sheep and goat Hence there evolved at a very early period in the vast grasslands and deserts of these continents peoples, who renounced the precarious existence of the chase and escaped the drudgery of agriculture, to form most perfect types of pastoral communities.

The utilization of mountain pastures for stock raising is universal Japan, however, failed to develop pastoral life at any stage in its history, although mountains cover two-thirds of its area The probable reason is the absence of any wild fodder plants in Japan and the exclusion of all foreign forms by the successful competition of the native bamboo grass, which has sharp, stiff, serrate edges and is said to cut the intestines of horses and sheep

America is poor in indigenous domesticable mammals North America had only the reindeer and buffalo, and South America the guanaco, llama and alpaca The last two were domesticated in the Andean highlands, but these were restricted to altitudes from 10,000 to 14,000 ft, because here alone suitable grass for their grazing could be had Stock raising in pre-Columbian South America, therefore, was merely an adjunct to the sedentary agriculture of the high intermontane valleys, and never became the basis for pastoral nomadism on the grassy plains But, when the Spaniards introduced horses and cattle into South America, the Indians and the half-breeds of the llanos and pampas became regular pastoral nomads known as llaneros and guachos

It is not without reason that the earliest civilizations in the old world developed in the region extending from North-Western India to Central Asia and the Eastern Mediterranean. It was so because this is the region which is the homeland of most of our important food plants and domestic animals.

A separate civilization developed in Central and South America, which is the homeland of maize, potato, sweet potato, pea-nut, etc, and of llama and

alpaca among animals. Maize, however, is a much less nutritious cereal than wheat, and llama and alpaca are no match for the horse and the cow. The result has been that these new world civilizations could not stand even the first attack from the old world, which began with the voyage of Columbus, and they were completely destroyed in a short time.

Though most of the world has advanced far ahead, throughout arctic Eurasia the people have not advanced beyond the pastoral stage. This is so because the only animal that can live there is the reindeer and the only plants that can grow are the lichen and moss which provide the food for the reindeer. The people pasture their herds of reindeer over the moss and lichen tundra and supplement their food supply with hunting and fishing. The introduction and breeding of new varieties of food plants by Russian botanists and the new techniques of agriculture such as vernalization, however, may change the situation.

Spices

The value of spices as condiments, flavourings and food preservatives was realized at a very early date in the history of mankind. Most of the important spices, however, originated in tropical Asia. Although they were amongst the first objects of trade between the East and the West, the quantities that reached Europe were very limited and the demand very great. This made them very precious objects. They were as eagerly sought after as gold and were used in lieu of money. For instance, when Goths captured Rome about 400 A.D., 200,000 ounces of pepper was one of the principal items of ransom demanded. Englishmen used to pay rents in pepper, and the pepperer's guild is a relic of the days when this spice was considered as precious as silver and gold. The craving for spices has been one of the great factors in human progress and has greatly influenced the course of history and international relations. The quest for them created a furore in Europe comparable only to the Crusades and was one of the dominant factors in European history in the Middle Ages. It led to the discovery of new lands, shorter trade routes, conquest and colonization of many tropical countries, where spices grew or could be cultivated. As if guided by spicy breezes, Portuguese navigators crept warily round the bulk of Africa and discovered the sea-route to India. Columbus, a sailor bolder then all the rest, sought in the West the spices of the East, and discovered a new world. Battling for spices, Portuguese, Dutch, French and English left a trail of blood in India and Indies. Ceylon, for example, produced cinnamon. The Portuguese landed on the island in 1505 and began to trade in this spice. They siezed the island in 1636 because of this spice and levied a tribute on it from the native rulers. The Dutch expelled the Portuguese in 1656 and siezed the spice trade of the island. The British finally drove away the Dutch. Spices today are a minor issue in politics, but the end of the political changes they brought about is not yet in sight.

Tea, like spices, has also played a prominent part in the opening of the Orient to occidental commerce.

Potato

Peru-Bolivia is the undoubted home of the potato. It was on account of the presence of wild potato plants in the Andean mountains that men of the Amazonian basin could move westwards and establish a foot-hold on these inhospitable heights, which afterwards flowered into a remarkable civilization. Again, after the discovery of the New World, the great Potosi Mines, which brought huge fortunes to the Spaniards, were worked with slave labour maintained almost entirely on dried potatoes.

Potato has been both the saviour and the ruin of Ireland. It reached there at the end of the 16th century, at a time of great civil turmoil, when agriculture in a very large part of the country had been completely devastated. It fitted perfectly into the lives of the hunted, semi-starved population and spread rapidly. As it was easy to grow, easy to harvest, easy to hide, it provided good enough nourishment for a large majority of the population and gradually affected the entire social fabric of the people. As the effort required for its cultivation was very little, the people became lazy and the standard of living shrank to the lowest level in Europe. As Salaman* has put it, "the shape of men's lives was literally fashioned by the potato. It took the place of money and it dictated the size and tenure of their holdings. Above all, its general abundance removed from the peasantry any sense of family responsibility, pride of home or person. Marriages were entered into light-heartedly and the number of children in the family was a matter of no moment, for there were always enough potatoes to go round". It was in these conditions that suddenly in 1845 and 1846 the potato blight, caused by the fungus *Phytophthora intestans*, swept all over Western Europe and British Isles. Ireland, whose dietary was completely dominated by the potato, suffered an unparalleled disaster. The complete failure of the potato crop not only caused the death of about a million people from sheer starvation, but also culminated in a great wave of emigration which led another million to leave their native land during the next few years.

* *New Biology*, edited by M. Abercrombie and M. L. Johnson, Penguin Books, London and New York, 1945, p. 23.

Potato has also played an important part in the economic development of England following the Industrial Revolution As the setting up of factories led many village people to leave for towns and cities, a cheap diet was necessary for them Potato alone could maintain life at low price and thus proved a boon both to the master and man It reduced the cost of production and thus helped in the rapid growth of nation's wealth

Other Economic Plants

There is a strong contrast between the flora of the tropical and temperate countries, while many plants of temperate regions can be cultivated in tropical mountains, the torrid zone produces numerous articles which can never be grown on a commercial scale in cold countries We have already referred to spices, etc and the tropics also produce many other food materials and raw materials essential to the well being and military efficiency of the industrially more advanced countries of the temperate zone Hence the great reluctance of many of the European countries to part with colonial empires This is also, in great part, responsible for the policies of aggression that many countries have pursued in recent years The Italian attack on Abyssinia, the pre-war German demand for the return of her colonies, and the Japanese struggle for the possession of South Eastern Asia are cases in point War would easily disappear from the globe if the industrial raw materials, many of which are obtained from the plants, were equally distributed over the world Hitler might not have attacked Russia if his Europe had been self-sufficient without the granary of Ukraine This might have changed the whole course of the Second World War And in the long run, the lack of suitable raw materials has been one of the main factors in the defeat of Germany in the Second as in the First World War

The richness of any region in plant wealth has always been a potent factor in its history The deserts and bleak mountain ranges attract little attention, while the fertile valleys are always a temptation to their neighbours The comparative richness of India in food plants in the past has always invited invasion from her hungry neighbours in the North-West.

Type of Vegetation

The type of vegetation, particularly before the days of the aerial warfare, greatly affected army movements The open grasslands help rapid movement, while dense forests are a great impediment The Mongols in the 13th Century, for example, swept right across Asia and Russia and in 1241 even defeated a mixed army of Poles and Germans at the battle of Liegnitz in Lower Silesia However, they could not continue their drive beyond, on account of the dense woodlands and so turned southwards to Hungary There are numerous other instances in history where a weaker party has taken advantage of the forest and thus prolonged a battle and avoided defeat The surprising initial success of the Japanese in the recent war was accomplished by taking full advantage of the dense forests of South-Eastern Asia and Burma There is also a legend* that once upon a time an Indian grass *Cenchrus catharticus* Del , called 'bhurat', which has very bristly spikes, was pitted against an army, and won An emperor from Delhi was marching on Bikaner, when a burr of *bhurat* stuck in his arm He picked it off, and it stuck in his finger He next tried to bite it off, and it stuck in his lip and caused him even greater pain. When told that the country was full of this grass, he ventured no further and Bikaner was left in peace.

Plants in Relation to Social Ills

Plants, and to some extent animals, have been and still are responsible for many of the social ills that beset mankind The system of slavery in Southern United States went hand in hand with the cultivation of cotton Production of indigo in Bihar has been associated with many cruelties on the peasant cultivators and labourers The barabarities of Congo in the reign of King Leopold II of Belgium, which shocked the whole civilized mankind, were perpetrated to collect rubber and ivory † The greed for spices also wrote one of the blackest chapters in the troubled history of European dealings with darker races In Ceylon, the caste of cinnamon collectors *chalias* was cruelly oppressed first by the Portuguese and later by the Dutch Many were even tortured to death or slain.

An important social problem of modern civilization for which the plants are responsible is the narcotic drug habit and the illicit trade that has grown up around it

* Coldstream, W —'Illustrations of some of the grasses of Southern Punjab', London, Calcutta and Bombay, 1889

† Stanford (Economic Plants, New York and London, 1934, p. 179) gives the following account of the atrocities committed on the natives of Congo "Principal resources of the region were rubber and ivory, and collection of both was enforced on helpless natives by the most abhorrent means Villages were "taxed" huge quantities of ivory and rubber, negroes failing to produce their quotas were flogged, tortured, mutilated, or killed in cold blood Women and children were held as hostages to be ransomed in rubber, and they were whipped, brutalised, and disfigured when ransom failed The "hand maimed host" of the Congo is said to have been numbered in thousands and tens of thousands For constabulary in the rubber forests, cannibals were recruited and allowed to commit the most bestial excesses."

Horse

One of the reasons for the quick success of Islam in its Westward march, besides the rotten-ness of Graeco-Roman Society, was the improved cavalry, whose knowledge the Arabs got from the Chinese through the Persians The bewildered foot soldiers in the West found it impossible to stand against the horsemen from the Middle East It was the horse again which defeated the elephant-armies of Porus in 326 B.C, when Northern Punjab was invaded by Alexander the Great

Fisheries

The animal life of the water has exercised no less influence on the social relations and history of man than the land animals According to Semple,* it is important to man not only due to its great abundance, but also on account of its distribution over the coldest regions of the world It is the main source of food of polar and sub-polar peoples, and therefore is accountable for the far-northern expansion of the habitable world Even the reindeer tribes of Arctic Eurasia could hardly subsist without the sea food they get by barter from the fishermen of the coast Norway, where civilization has achieved its utmost in exploiting the limited means of subsistence, shows a steady increase from South to North in the proportion of the population dependent upon the harvest of the deep Proximity to the general border of the ocean has determined the selection of the village sites among the coast Indians of British Columbia and Southern Alaska, among all the Eskimo, and numerous other peoples of Arctic lands Not only in the polar regions, "but also in the other parts of the world, the presence of abundant fishing grounds has drawn the people of the nearest coast to their wholesale exploitation, especially if the land resources are meagre Fisheries then become the starting point or permanent basis of a subsequent wide maritime development, by expanding the geographical horizon. It was the search for the purple yielding shell fish murex that first familiarized the Phoenicians with the commercial and colonial possibilities of the Eastern Mediterranean coasts The shoals of tunny fish, arriving every spring in the Bosphorus from the North drew the early Greeks and Phoenicians after them into the cold and misty Euxine, and furnished the original impulse to both these peoples for the establishment of fishing and trading stations on its uncongenial shores" The Hanse towns of Germany owed much of their prosperity to the fisheries of the Baltic and especially to the summer catch of the migratory herring which visited the shores of Pomerania and Southern Sweden in vast numbers to spawn When in 1425, on account of some unknown cause, the herring abandoned the Baltic and selected the North Sea for its summer destination, a fresh support was given to the wealth of the Netherlands There is considerable truth in the statement that Amesterdam was built on herrings

The food resources of water perhaps first tempted man to trust himself to its dangerous surface and led to the invention of the boat, which after the discovery of fire has been regarded by many anthropologists as the next most important step in the progress of the human race It transformed the barrier of the untrod waste into highways for journeys to distant lands and brought together people from different parts of the globe

The co-operation and submission to a leader necessary in pelagic fishing often gives the preliminary training for higher political organization "Fisheries have always been the nurseries of seamen, and hence have been encouraged and protected by governments, as providing an important element of national strength The casual connection between the fisheries and naval efficiency was recognized in England in the early years of Elizabeth's reign, by an act aiming to encourage fisheries by the remission of custom duties to native fishermen, by the imposition of a high tarrif on the importation of foreign fish in foreign vessels, and finally by a legislative enforcement of feasts to increase the demand for fish, although any belief in the religious efficacy of fasts was frankly disclaimed" The history of Japan again affords a very striking illustration of the power of fisheries alone to maintain maritime efficiency By the Seclusion Act of 1624, all her merchant vessels were destroyed, the marine was restricted to small fishing and coasting vessels, and navigation was confined to Japan's own narrow island world The fisheries, nevertheless, kept alive that intimacy with the sea and preserved the nautical efficiency that was destined to be decisive factor in the development of awakened Japan

Fur-bearing Animals

The arctic region is rich in animals with beautiful furs. The early French colonizers in Canada took to the very profitable fur trade, which was facilitated by their possession of the great rivers, St. Lawrence and Mississipi This led to their excessive expansion, attenuated their ethnic element and failed to raise the economic standard of their wide border district. Therefore, when attacked, they could offer only slight resistance to the solid English settlement, and were defeated (Semple, *loc cit.*).

* Semple, E C—Influence of Geographic environment on the basis of Ratzel's system of anthropo-geography, London, 1913

MICROORGANISMS AND INSECTS

The bacteria, protozoa and viruses on the one hand, and flies, fleas and mosquitoes on the other, appear an insignificant part of the flora and fauna of the world. However, as causal agents and carriers of many epidemic diseases, they have had profound influence on the human history As Zinsser* has put it, "Swords and lances, arrows, machine guns, and even high explosives have had far less power over the fates of the nations than the typhus louse, the plague flea and the yellow fever mosquito" They have determined more campaigns than Caesar, Hannibal and Napolean "Civilizations have retreated before the plasmodium of malaria, and armies have crumbled under the onslaught of cholera spirilla, or of dysentry and typhoid bacilli Huge areas have been devastated by the Trypanosome that travels on the wings of the tsetse fly, and generations have been harassed by the syphilis of a courtier" Man from his anatomy is generally believed to have evolved in the warmer parts of the world and certainly not in the very cold It is very likely that the mosquitoes had a very large share in driving him to the cold temperate regions Below are given a few instances taken from the very interesting book of Zinsser, where it is very clear that disease was the most important factor in deciding the result of a battle or a campaign

'The sieges of Syracuse by Carthaginians in 414 and 396 B C were relieved by disease, probably plague In the civil war of Rome, in 88 B C. the victory of Marius was decided by an epidemic, which killed 17,000 soldiers in the army of Octavius In 425 A D the Huns gave up their otherwise unimpeded advance upon Constantinople on account of an epidemic of an unknown nature The 'Sacred Fire' which turned back the armies of the king of Abyssinia attacking Mecca was either a severe epidemic of small pox or perhaps a combination of erysipelas and general staphylococcus infection Epidemics played a very prominent part in deciding the fate of the Crusades The centuries of struggle between Spain and France were again and again decided by plague and typhus The armies of the German Emperor, Albrecht attacking Bagdad in 1439 were defeated by dysentery Syphilis disorganized and dispersed the army of Charles VIII at Naples after the city had been taken by the French

The siege of Motz by Charles V in the 16th Century was raised by scurvy, dysentery and typhus, and the army retreated from the city after 30,000 men had died. A typhus epidemic dispersed the army of Maximilian II of Germany, who was ready with 80,000 men to attack Sultan Suliman in Hungary In 1560, such a deadly and violent epidemic broke out at the camp at Komorn, that the campaign against the Turks had to be given up The thirty years war was in all its phases dominated by deadly epidemics In 1643, Charles I was forced to give up his plan of advancing upon London against the Parliamentary army under Essex by a typhus epidemic In 1708, the Swedes after having defeated the Russian armies completely lost the fruits of their victory by an outbreak of plague In 1741, Prague surrendered to the French army because of 30,000 deaths among the opposing Austrian soldiers on account of typhus The outcome of the French Revolution was also to some extent decided by disease In 1792, Frederick William II of Prussia, with Austrian allies, at the head of 42,000 men, was marching against the armies of the Revolution Dysentery, however, decided in favour of the French Republic

The establishment of the Haitian Republic is generally attributed to the genius of Toussaint l' Overture, but it was actually brought about by the yellow fever In 1801, Napoleon sent General Leclerc with 25,000 soldiers to Haiti to put down the revolt of the negroes, the French were succeeding in their object, but the epidemic of yellow fever killed 22,000 Frenchmen and completely disorganized the French army

Even the greatest general, Napolean, was helpless when pitted against the tactics of typhus and dysentery It was disease that annihilated his armies at Moscow, and broke his power in Europe more effectively than military opposition or even Trafalgar'.

* Zinsser, H —Rats, lice and history, London, 1935

ASSOCIATION OF SCIENTIFIC WORKERS (INDIA)

M N SAHA

HISTORY of the Associations specifically meant for workers all over the world, scientific workers not being excepted, is the history of the struggles of the workers for a better life. As it is well known, trade unionism was not born out of fashion, but out of hunger and misery ; exploitation and degradation have been the precursors and stimulants to the idea of uniting in one body to fight the contrary forces. And an Association of Scientific Workers is no academic body aiming "to improve the knowledge of

natural things . not meddling with Morals, Politics " but it is definitely pledged to meddle in morals and politics whenever compelled to do so Scientific workers refuse to stand aside any more and be silent witness to their fruits of labour being lost in wars while in peace time they remain a vast mass seething with frustration and demoralization

The last war has made it clear that whoever works for the society, irrelevant of the nature of his work—with brawn or brain, has right to say as to how his labour shall be used for the society, as also to lay down the terms of his labour And to achieve this end the workers have fully realized that *in unity lies their strength and that their unions are their fortresses* That is why, during the war, trade union movement grew in leaps and bounds in all corners of the globe, not excluding India, and the progressive forces today are far more powerful than they were right after the first world war. Let me hasten to add, lest I be misunderstood, that by workers I mean all those who have to work for others—institutions or individuals alike—in order to earn the bare necessities of life, whose only capital is the capacity to labour, who are at the mercy of their employer with regard to the tenure of their service, and whose fruits of labour form property of the employer Workers are workers irrespective of the cleanliness of their 'dhoti' Thanks to the inflation, any demarcation between salaried men and wage earners has vanished and paved the path for the various shades of workers to unite for a common purpose.

As a scientist, I must confess, and this I do after careful consideration, that the scientific workers have proved to be the most tragic section of the working class By scientific workers I mean anyone who has to depend for his living as an employee on the exchange of his knowledge or experience he has gathered in a scientific subject It is immaterial whether he is a professor, research student or laboratory assistant, engineer or technician, doctor or compounder, agriculturist or chemist It cannot be denied that it is the scientific worker who has largely to be complimented for the material benefit *accrued* on this earth which has enabled the common man to escape the terrible conditions of the serf and the plebian of medieval times Scientific discoveries in fundamentals and applied branches have made the world what it is today But the vast mass which has helped to bring happiness to mankind and hope to individuals until recently in certain countries now had no say in the matter as to how their fruits of labour shall be best used , instead, they were compelled to play the part of "hewers of wood and drawers of water", while entrenched greed and selflessness have usurped the produce of the scientific workers, which are results of the sweat of brow of the millions of silent workers And what are the results? A devastating World War every twenty-five years, due to the emergence of political maniacs, in which the solid work of improvement in the conditions of the man done during previous years are thrown away This vicious system must go But this Augean stable cannot be expected to be cleaned unless serious efforts are made on the basis of a common front I am aware that the obstacles before us look like unsurmountable, but let us remember that it is against the current that an organism thrives provided it shows its will , and an organization is not much different from an organism in this respect

The Association of Scientific Workers (AScW) in Great Britain thrived only during the most critical periods of the last war It was during this period that the scientific workers, alongwith their comrades in every other section of the society, felt most acutely the cruelties and injustice meted out to them. They all struggled and struggled strenuously, unitedly and with definite objects in view The magnitude of success attained by the Association had dispelled all doubts in the minds of the hesitants and made the members of the Association more determined and adhere to the organization more resolutely At the last election, this Association was able to send over a dozen of its members to the British House of Commons in order that their voice is heard by the law makers, while the contribution from its members in one year amounted to £54,000.

It is true that the movement of the scientific workers had taken its birth in Great Britain , but it has now penetrated all the civilized countries, gathering momentum every day and has now become an international force in the shape of the World Federation of Scientific Associations

America, France, Norway, Denmark, Holland, Belgium, Checkoslovakia, Italy, Republican Spain, Canada, Australia, New Zealand all these countries have built their own organization Scientific workers even in China, which for about a decade has become veritable home of civil war and national calamities, have realized that their salvation and to some extent that of their country lie in their organizational strength Even Iran which for us until recently was only one more country on the world atlas, has already started its organization and has been hitting hard with its only weapon of collective bargain At least the two last named countries will prove my previous assertion that such an organization as the AScW with definite bias for trade unionism is motivated not by airy cultural inclinations but necessitated by environmental conditions of the workers themselves It is needless to point out that learned societies have their own value—in their specific fields—but their purpose is quite different

from those of the AScW. In one of the memoranda, "The AScW and Other Bodies" drawn by the AScW in Great Britain it has been aptly explained that an individual "as a scientist should be a member of his scientific institute and as a worker he should be a member of his trade union There is no question of alternative here—both are necessary and, in fact, are complementary"

Let me remind here that the persons holding the oars of the organizations mentioned above are no parliamentary busy-bodies, but scientists themselves This fact alone would indicate how deeply the scientific workers have realized the importance of such an organization for the better use of scientific knowledge in their country as also for safeguarding their own material interests The French Association of Scientific Workers can take pride in having Prof Frederic Joliot as its president Personages like Sir Robert Robinson (President of the Royal Society), Sir Robert Watson-watt, Professors Bernal and Blackett, Julian Huxley and G H Hardy, Sir Richard Gregory and Sir John Russell, all my friends and Fellows of the Royal Society are associated with the AScW in Great Britain Similarly, my friend, Dr Harlow Shapley, the noted astronomer in U S A, Academician Semenov in Moscow and Prof Belehradek in Czechoslovakia—every one of them leaders of thought in their own lines—are vitally connected with the Association in their own country

The trials and tribulations facing the scientific workers in India today are far more serious than those of their colleagues in other parts of the world The workers over here can no longer wait to remain isolated and aloof from the efforts made internationally to redress the grievances Miseries of the scientific workers in India can be and have to be eradicated primarily by themselves We may expect to get certain amount of guidance and experience from our colleagues beyond our shores but then to build up an organization and develop a movement is *our* own job Any further delay would create a havoc as we can clearly envisage

Now that the war is over, people and their government in all countries have been thinking in terms of post-war reconstruction in every sphere of their life. Some countries are more serious than others while some have better facilities than the rest Unfortunately, in India neither have we much of a plan nor any seriousness of purpose behind it Lest you or the public misunderstand me let me quote from a speech by Dr John Mathai, late Finance Member, and at present Member in charge of Industries. Says Dr Mathai·

"I may say, the same may be said of the Central Government Projects. Why it is so?. As I said elsewhere, politicians in our countries are continuing to talk only of matters which divide one party from another, of special rights, privileges, votes, religions and provincial differences, and brought about the present chaotic state I would ask them to call for a truce for three months, and talk of things in which every Indian has a stake food, clothing and housing, employment, development of industries and agriculture In that way alone, we can discover a common purpose in life, and achieve unity"

The result of seriousness of purpose in dealing with the plans has been that since the cessation of hostilities, panic has begun to arise in the mind of those who remain employed and those who were employed erstwhile The panic has its justifications. In spite of the tons of paper having been used by official and non-official bodies for the sake of planning, the grave problem of unemployment has already made itself manifest in an alarming degree To give one example, the Mathematical Instruments Office at Calcutta which increased its staff nearly five times during the War, have already dismissed two-thirds of their employees, some amongst them being skilled workers, whom no Government would think of losing The virus of unemployment at this juncture is a dangerous sign for the workers as a whole and scientific workers in particular There are thousand and one ways of employing the scientific workers for the benefit of the society, if they could help to win the war, whether they supported it or not, surely they can win the peace and make it stable Circumstances which create unemployment are also responsible for naked exploitation, financial and otherwise If in the recent past we had more jobs than trained personnel, very soon we shall have far more men than jobs available Considerable reduction in the factories, workshops and institutes give out the warning If we may remember what happened in the early thirties, let me emphasize, that the shape of things to come will be several times more severe Those who will be out of employment will have no hope and those in employment will have no peace unless the people themselves come forward to take part in altering the situation

Let me give you warning of another impending crisis The Government of India have sent within the last three years about 1,500 young men of having the highest university training to their credit, for training in technical subjects in foreign countries I have grave doubts about the wisdom of this step, in so far as it has been made the excuse for starving the higher research institutions attached mostly to universities and neglecting fundamental research They all expect to be Burra-Sahibs, but I think they will swell the ranks of scientific workers But what is most tragic is the fact that, to my knowledge, no constructive work worth mentioning has so far been taken up, which can absorb all these young men on their return. The constructive works of which you

heat, and on which our honourable members waste so much eloquence are all progressing at snail's pace, and nobody knows when schemes will be ready for absorbing these young men.

While attending the sessions, as the representative of India, of the World Federation of Scientific Associations held in London last July, I felt convinced that responsibility of scientists today is no more limited to determination of scientific facts alone but it extends to those who are behind the scene It is a solemn responsibility of a scientific worker to save the dignity of his profession and to save his profession from becoming a mere tool in the hands of those who, by no logic or morals, should have the sole right to provoke a disaster It is high time for the scientific workers in India that they exert their inherent right to live like decent citizens and shoulder responsibilities for the betterment of their motherland

Since my return in August last, I have been directing my efforts to build up an organization in India Though for the last few months India, and specially Bengal, has been facing calamity of the worst magnitude, nevertheless I am happy to announce that a provisional committee has already been set up, of which I am, for the time being, president. Formal inauguration of the newly started Association of Scientific Workers (India) will be held during the ensuing sessions of the Indian Science Congress Professors Blackett and Bernal have been specially requested to see if they can find their way to attend the inauguration of the Association

I appeal to all those who can claim to be scientific workers to become members of the Association and strengthen it to fight the evil forces which have held the scientific workers from taking their rightful stand among those who are striving to make the country a place worth living

Notes and News

POST-WAR PLAN FOR ASTRONOMICAL AND ASTROPHYSICAL DEVELOPMENT IN INDIA

Towards the end of 1945, Government of India appointed a Committee for the planning of the post-war development of astronomy and astrophysics in India, with Prof M N Saha as chairman and Dr S K Banerji, Prof M. Ishaque, Dr A L Narayan, Prof D S Kothari, Prof. K S Krishnan, Rao Shaheb T P Bhaskara Sastri, Prof S Bhagavantam and Prof A C Banerji as members This Committee have recently submitted their plan, both long-range and short-term, which the Government have now published for general information

With regard to the general expansion of astronomical and astrophysical research, the Committee have recommended that immediate steps should be taken for the institution of astronomical observatories in some of the Indian universities To start with, the three universities of Delhi, Aligarh and Benares, which are financed by the Government of India, should be provided with necessary funds to obtain equipment for building astronomical and astrophysical observatories It is hoped that the example of the Government of India will be followed by the Provincial Governments in taking similar steps for the promotion of astronomical and astrophysical work in their respective universities

In their long term plan, the Committee envisage the establishment in Northern India of a Central Astronomical Observatory provided with a large sized telescope for special stellar work The Committee recommend that a small committee should be appointed to go into the details of the planning of this Observatory and to select a suitable site. In planning the programme of work and equipment of this Observatory, due consideration should be given to the very important astrophysical work now carried on by the Nizamiah Observatory so that unnecessary duplication may be avoided

The short-term plans concern the expansion of the activities of the Kodaikanal Observatory The Committee recommend that the work of the Observatory should be carried on under three main sections, *e g* , (1) Solar Physics, including laboratory work on atomic and molecular spectra, (2) Planetary and Stellar Spectroscopy, and (3) Ionospheric and Magnetic work

In view of the great changes in the instrumental technique for the study of physics of the sun, the Committee recommend that the present activities of the Observatory should be modernized and expanded as follows:

(1) Systematic study of the corona with a coronagraph of Lyot type.
(2) Obtaining motion picture equipment for spectroheliograph as in the McMath-Hulbert Observatory.

(3) Installation of a Tower Telescope for observation of the chromosphere and the prominences as in Mt Wilson Observatory

(4) Study of the solar spectrum in the infra-red and ultra-violet

(5) Study of the magnetic field of the sun and the field near the sun spots

(6) In India, there is no astronomical observatory equipped with the highest precision pendulum clocks of the Shortt-Synchronome free pendulum type One set of this type of clock should be maintained at Kodaikanal Observatory for accurate time determination

The spectroscopic work and the photometry of the stars, for which Kodaikanal is best suited and also has a fair tradition, should be revived and actively pursued under the proposed new section of Planetary and Stellar Spectroscopy Similarly, for the ionospheric and magnetic work, the Committee recommend another new section They have pointed out that Kodaikanal, by its geographic location near the magnetic equator, is best suited for such work and should undertake daily observation of the heights of F, F' and other layers, measurement of the ion strength and such other work, for which necessary equipment will have to be provided The International Union of Geodesy and Geophysics also recommended the establishment of a magnetic observatory in India near the equator, and this section would largely meet this requirement Provision for a cosmic ray unit for measurements of cosmic ray intensity has also been recommended

The Committee have been fully alive to the need for a City Station closely associated with an active research centre For want of such a Station, much of the research spirit among the workers of the Observatory, isolated from the general current of scientific life of the country is liable to be lost The Committee have, therefore, strongly recommended the establishment of a City Station at Madras This should be fully equipped with a library, and up-to-date spectroscopic laboratory, a well-equipped machine and optical shop and should have working rooms, not only for the members of the Kodaikanal Observatory, but also for visitors from other parts of India. It should have close connection with the University of Madras and should take students for post-graduate research work from all parts of India The workers of the Kodaikanal group should not spend all their time in Kodaikanal Observatory, but should be periodically sent to the City Station, for general scientific contacts and to take part in University teaching and research work An old site at Nungambakkam in the city of Madras, still in the possession of the India Meteorolgical Department, has been recommended for the location of the proposed Station

The Committee recommend that the Kodaikanal Observatory with its City Station and the proposed Central Astronomical Observatory should be under the general Administrative Control of the Director General of Observatories Further, there should be constituted a standing Astronomical Advisory Body consisting of seven members, of whom four will be non-officials,—each a distinguished scientist interested in astronomy and astrophysics, and three will be officials The Director General of Observatories, the Director of the Kodaikanal Observatory and the Director of the Nizamiah Observatory will be the three official members The Director of the Central Astronomical Observatory will be included later

The Plan also recommends establishment of a Naval Observatory on the model of the Naval Observatory at Washington or the Royal Naval Observatory at Greenwich, and preparation of Nautical Almanac For the former, the Committee are of opinion that the Colaba Observatory will probably be the best place for the establishment of such an Observatory

RECONSTRUCTION OF THE DNIEPER HYDRO-ELECTRIC STATION

The Soviet newspaper *Moscow News* has recently reported satisfactory progress in the reconstruction of the famous Dnieper hydro-electric station destroyed by the Germans during their invasion of Russia in 1941-42 The restoration work at the Dnieper station has been in progress since 1944, while the war was still on The construction of the dam is reported to be complete in the main and before long the under-water structures will also be restored To date 200,000 cubic meters of reinforced concrete sections have been dismantled, some 120,000 cubic meters of concrete poured, and about 10,000 tons of sections and equipment assembled The erection of the building to house the station is almost complete, and the general expectation is that the Lenin Hydro-electric Station on the Dnieper will go into operation early this year

The Dnieper Hydro-electric Station which was surpassed in output only by the Grand Coulee and the Boulder Dams in the U S A had, before its destruction, an annual production of about 2,500 million kw-hrs Nine vertical Francis turbines with a capacity of 103,000 h.p each were mounted here. It generated more power than all the power stations of the Tsarist Russia, taken together, had ever done In March 1927, the Soviets first started work on the dam and on the power

station which went into production in October, 1932 It is said that the quantity of earth excavated during the work was sufficient to girdle 'the globe at the equator with a strip one meter wide and 24 cm thick.'

The Dnieper Dam, by making available abundant and cheap hydro-electric power, was the greatest single factor in the rapid industrialization of the Ukraine and the Donbas areas, which followed in the wake of successive Five-Year Plans Heavy industries producing iron and steel, aluminium, harvester combines, chemical and various other products were developed in these areas At Dniepropetrovsk, large steel mills producing various grades of metal, including high-grade alloys for automobile and aircraft motors, and large sheet rolling mills were established At Dnieprodzerzhinsk, another industrial city on the Dnieper, several blast furnaces were built to work the ore from the Krivoi Rog Basins Formerly, the Krivoi Rog iron ore used to be exported outside Russia, particularly to Germany, and the country imported the finished metal and metal products at considerably higher prices In the same way, the manganese ore from the neighbouring Nikopol mines fed the newly built Soviet plants in the Dnieper area and found new uses in the country of its origin Power from the Dnieper Dam has also led to the development of a large aluminium plant and two large machinery plants in Zaporozhye

As a result of invasion, these factories and plants have met the same fate as the hydro-electric station itself Although some of the removable plants and machinery parts were evacuated to the interior, much remained, such as the blast and open-hearth furnaces, to be turned into heaps of rubble due to heavy bombing Restoration work has also started in these industrial areas, and much progress has already been reported

CHEMICAL AND PHARMACEUTICAL INDUSTRIES IN INDIA

ALMOST the entire field of chemical and pharmaceutical industries in India was reviewed by Dr K A Hamied in course of his presidential address before the seventh annual general meeting of the Indian Chemical Manufacturers Association, held at Delhi on November 21, 1946. Dr Hamied, it might be recalled, was the head of a delegation of Indian Chemical Manufacturers, which recently visited the United Kingdom and the U S A. for the purpose of studying the developments in the sphere of chemical and pharmaceutical industry during the last ten years, and also of gaining first-hand knowledge of the methods of research and the system of collaboration between the industry and the centres of scientific research The rich experience gathered during this visit has enabled him to make an objective review of the whole situation, which deserves careful attention of all concerned with the development of chemical and pharmaceutical industries in India.

Referring to the sulphuric acid industry, an important heavy chemical industry, Dr Hamied pointed out that, as a direct result of the war, the production increased from the pre-war figure of 70,000 tons annually to 100,000 tons annually Yet this figure was insignificant compared to the U S production of 9 million tons and the U K production of 1 5 million tons It is apprehended that there may be difficulty in consuming even this amount if further development of chemical industries is not assured He referred to the fertilizer industry which is a big consumer of sulphuric acid The Government of India have recently undertaken to build a synthetic ammonium sulphate plant to make available nitrogenous fertilizers, but have ignored the equally important claims of manufacturing phosphatic fertilizers Best results are reported when a mixture of ammonium sulphate and superphosphate, in the proportion 1 to 1 5 is used On this basis, the Government of India which have contemplated to produce 400,000 tons of ammonium sulphate, should also undertake to manufacture about 600,000 tons of super-phosphate This will not only assure a steady and high consumption of sulphuric acid by a single industry, but will make possible more balanced use of synthetic fertilizers Besides, the manufacture of many other chemicals, such as the sulphate of alumina, magnesium sulphate, ferric sulphate, sodium sulphate, bichromate, thiosulphate, nitric and hydro-electric acids and several coal tar intermediates, depends on the availability of sulphuric acid whose production, therefore, can be greatly accelerated when these are fully established

Among other chemicals developed during the war, Dr Hamied mentioned magnesium chloride, bichromates, alumina ferric, sodium thiosulphate, nitric and hydrochloric acids, caustic soda, soda ash and chlorine But many important primary chemicals such as chlorosulphonic acid, glacial acetic acid, acetic anhydride, butyl alcohol, amyl alcohol, citric acid, and the elements like sodium, magnesium and phosphorus, still cannot be manufactured in India Coal tar distillation is still very seriously neglected, and little attention has so far been paid to the production and development of very important basic coal tar derivatives.

In contrast with the heavy chemical industries, progress made by the pharmaceutical industries, in the opinion of Dr Hamied, has been satisfactory. Several fine chemicals which formerly used to be imported are now being made here, *e g.*, potassium

permanganate, chloral hydrate, stearic acid, calcium lactate, chloroform, ethyl chloride, nicotinic acid and, among alkaloids, strychnine, caffeine, santonine, morphine, codeine and to some extent emetine The main difficulty in the further expansion of the pharmaceutical industries are the lack of basic raw materials which cannot be made available unless the heavy chemical industries have been satisfactorily developed He referred to the necessity of the Drug Act which would come into force from February, 1947 and emphasized the need of early establishment of Chemical and Drug Testing Laboratories in all Provinces and at the Centre

Dr Hamied invited attention on the necessity of setting up an Institute for Chemical and Pharmaceutical Research on a co-operative basis He revealed that the Council of Scientific and Industrial Research unofficially assured the Association of their full co-operation financially and otherwise in the establishment of this institute In his concluding remarks, he drew pointed attention to such questions as transport, import duties, import trade controls, excise laws, restriction on the establishment and location of industries, taxation, etc , in all of which the government of the country is involved and on whose satisfactory solution depends largely the future progress of the chemical industries

BIOLOGICAL SCIENCES IN JAPAN DURING THE WAR

In a note in *Science*, June 28, 1946, J Linsley Gressitt of the U S Naval Medical Research Unit, who had been to the Pacific theatre of war, has revealed some important information regarding the state of biological sciences in Japan during the war Research in biological sciences had already received a serious setback on account of the war, but it practically came to a standstill after the very serious destruction of her research institutes and university laboratories as a result of indiscriminate and heavy American bombing

In Tokyo, the Agriculture College, the Science College and the Research Institute of Natural Resources, including the laboratories and valuable collections, were almost completely destroyed by fire The Imperial Agriculture Experiment Station, the Higher School of Agriculture and Forestry, and the Forestry Experiment Station are reported to have escaped destruction All the private ornithological museums in Tokyo, with the exception of that of Marquis Yamashina, were more or less destroyed Prince Takatsukasa's museum and Marquis Kuroda's collections of birds and mammals were completely destroyed The collection of Viscount Shibusawa's fish and anthropological collections, the private entomological museums of S. Hirayama and M. Kato and the Ueno Museum are intact.

In Hiroshima, the Science College and College of Agriculture and Forestry were destroyed, as was the Medical College in Nagasaki The Hydrobiological Station of Kyoto Imperial University at Otsu, the Marine Biological Station at Misaki, the marine stations at Asamushi and Shimoda are more or less intact

In Hiroshima, many members of the staff of the Science College, including Prof Hiraiwa and Assistant Professor I Sato, of the Zoology Department, were killed In Nagasaki, the president, 12 of the 19 professors, 10 assistant professors, and others of the Medical College were killed

Regarding research, biological sciences greatly suffered in Japan, only research bearing closely on the war effort being given encouragement Scientific publications were greatly reduced and many society or private scientific papers were discontinued Despite these handicaps, some new drugs of great value were developed Mr Linsley mentions two neocyanines, called *Koha* and *Shiko*, which are reputed to be helpful in the treatment of leprosy, tuberculosis, wounds, and burns

BOSE RESEARCH INSTITUTE

The 28th anniversary meeting of the Bose Institute was celebrated on the 30th November, 1946, when the 8th Sir J C Bose Memorial Lecture on 'Microwaves—Pioneer Work in India Half a Century Ago' was delivered by Prof S K Mitra, Ghosh Professor of Physics, Calcutta University In the course of his lecture Prof Mitra recalled the pioneer researches on microwaves—radio waves of less than one metre in wavelength, conducted by Sir J C Bose half a century ago The novel experiments of Sir Jagadish illustrating the optical properties of microwaves—their reflection, refraction, polarization and interference were demonstrated with the help of his original apparatus used for his lecture before the Royal Institution at London, in 1896

For the last 60 years, since their discovery by Hertz in 1887, microwaves had been only of academic interest and of no use in wireless telegraphy or radio. They have, however, come to the forefront during World War II due to their application in radar, the reason being that the shorter the wavelength the greater is the received radio energy scattered back by the distant aircraft to be located

In recalling the pioneer work of Sir Jagadish in this field, Prof Mitra emphasized that they are to be judged against the background of the state of science and technical knowledge half a century ago and also of the conditions under which a solitary investigator in this country had to carry out his work The modern developments familiar to the student of physics to-day were not even within the dreamland of anybody. The scientific world in that age believed

in the interpretation of Nature in terms of the Newtonian Laws. In this country there was no tradition of research. The Government was apathetic and considered Indians as incapable of doing any original work. It was under these conditions that Bose set out to investigate the properties of the microwaves which were then as novel as the atomic bomb is to-day. This he did with unprecedented precision and clarified many points which may seem obvious to-day Sir Jagadish's achievements under these adverse conditions fills one with wonder all the more because he had to devise everything single-handed with crude materials and with the help of ordinary mechanics

The wavelengths used by Bose went down to 2 millimetres in length and was the shortest known at his time. He used for the purpose a special type of transmitter and detected them with a coherer of his own invention The fact that waves upto 6 cm in length are not absorbed by air—as is now obvious by their use in radar—was demonstrated by Bose by passing his waves through a flask full of liquid air Of special interest was the phenomenon of total reflection by a thin film of air Theory demands that the film cannot be effective if its thickness is sensibly smaller than the wavelength No verification of this was possible with light waves Bose was the first to verify it with his electric waves Some of the microwave appliances now in practical use, *e g.*, horn radiator, wire grating for concentrating microwave beams were foreshadowed by Bose in the apparatus designed by him With his keen imagination and experimental skill, Sir Jagadish could rightly be described as the Faraday of India.

In course of his report on the work of the Institute, the Director referred first to those investigations which have arisen out of Sir J C Bose's plant physiological researches The first of these concern with the chemical nature of the mediator involved in the transmission of excitation in *Mimosa* This substance is probably a glucotanniod compound which plays, in plant tissues, a role similar to that of acetyl choline in the transmission of excitation in animal nerves and muscles The Crescograph is being used for the continuous growth record of young cinchona plants, whose mineral and other requirements are being investigated It is found that the growth is intimately connected with the opening of the apical bud, when it takes place in rhythms during the cool hours of the night ; each elongation is followed by definite small contraction An air-conditioned glass house is in course of construction, in which growth phenomena under controlled conditions can be studied

The bioelectric potential developed in germinating seeds is being studied along the lines initiated by Burr and his co-workers. The possibility of utilizing the electrical correlates of growth in germinating seed, for the purpose of seed testing and for finding out whether hybridization has been effected in seeds arising from crossing between two different pure strains, is being investigated under a grant from the Bengal Cotton Committee.

Through the courtesy of the I C I , it has been possible to test the efficacy of the weed killer Methoxone produced by them, for the eradication of water hyacinth The liquid in extremely high dilution was found effective in killing the plant and preventing further propagation from it, even when sprayed on a single leaf It represents a new kind of weed killer compared to the class of chemical poisons tested by Sir J C Bose twenty-five years ago at the instance of the Bengal Government, which only killed the leaves sprayed on, but did not prevent the vegetative propagation of the plant Further large scale field trials will be necessary, before the economic feasibility of using Methoxone as eradicator of water hyacinth can be established

Investigation on a pilot plant scale was undertaken in a jute mill on the processing of jute root cuttings by use of fibre retting substances like Hiparol developed in the Institute A considerable saving both in time and cost has been effected, as well as an increase in tensile strength of jute cloth woven out of bacterially retted fibres, as compared to similar cloth produced by standard method Tests on a bigger scale are being carried out in another mill in which the possibility of utilizing other fibres, like ramie, flax and coconut retted by this method, for the production of union fabrics with jute is also being investigated

The C S I R has approved of a scheme of atomic research for the production of transuranic elements submitted by the Institute Two research workers in physics of the Institute, Messrs S D. Chatterji and M S Sinha who were recently awarded the D Sc degree of the Calcutta University, have been recommended for senior appointments under the scheme

The Director announced that, as a result of recent negotiations with the Central Government, the administration of the Bose Institute, which during the last 28 years of its existance was in the hands of the trustees, will from the next month be taken over by a Council in which the trustees, the Central Government and Legislature and outside scientists will be adequately represented He pointed out that mere change in administration will not enable the Institute to meet the increasing and ever changing demand for pure and applied research growing up in this country, unless adequate long-term grants both for recurring and capital expenditure are made by the Central Government.

This will enable the Institute to fully utilize the

great tradition for original work built up by its Founder and the accumulated experience and skill of its workshop personnel for purpose of national development and welfare

TECHNICAL EDUCATION

THE meeting of the Executive Council of the Association of Principals of Technical Institutions (India) was held in Delhi on November 21, 1946 In his opening speech, Sir J C Ghosh, President of the Association, discussed, among other things, the position of the All-India Boards of Studies It is now decided that this Board, originally set up under the aegis of the Association, should henceforward function under the recently constituted All-India Council for Technical Education All-India Boards of Technical Studies for the following subjects have been created · Engineering and Metallurgy , Architecture and Regional Planning , Commerce and Business Administration , Chemical Engineering and Technology , Textile Technology ; and Applied Art Each Board has been constituted with one representative of All-India Council, two of A P T I , one of employees, two of professional bodies, one Inter-University Board and four specialists nominated by the Co-ordinating Committee of the Council of Technical Education Sir Ghosh emphasized the importance of the proper selection of members of the Board, which should include technical experts of great reputation and highest men in the technical profession It is only when such people sit on the Board that its diploma will carry sufficient prestige to be worth having He strongly expressed his opinion against the view held by many that diploma should be awarded on the basis of an All-India Examination 'Nothing could be more fatal to progress of technical education', said he, 'than the slavish imitation of this antiquated system of education' He asserted, and rightly, that technologists should be trained for understanding and not for memorizing general principles and processes and that they should develop practical skill in the application of these processes to the problems of production and utilization. Sir Ghosh very much deplored the present neglect of education in humanities and strongly recommended, for inclusion in the curriculum of higher technological education, these branches of humanities which will make the technologist a better citizen and a better administrator

COLONIAL RESEARCH FELLOWSHIPS

PROVISION has been made for 25 Colonial Research Fellowships within the period 1944-49 to encourage qualified scientists to give special attention to colonial problems and to enable them to pursue research work in the British Colonial Empire. The award will be made by the Secretary of State on the advice of the Colonial Research Committee

Fellowships carry remuneration at the rate of £400 per annum which may be increased to a sum not exceeding £750 per annum if the Fellow is married or in any other appropriate circumstances. Travelling expenses and the cost of any apparatus or material required for the Fellow's research will also be provided Where a Fellow is a member of a superannuation scheme in which his employer pays part of the contributions, the Secretary of State will, if necessary, also accept responsibility for the payment of the employer's contributions for the duration of the Fellowship The basic allowance is not subject to United Kingdom income tax if the period spent overseas covers a full fiscal year In other circumstances, however, he may be liable to assessment in the normal manner

The Fellowships will normally be reserved for University graduates in the natural or social sciences under 35 years of age from any part of the British Commonwealth and Empire Candidates must already have had research experience and must give evidence of their ability to plan and prosecute investigations of a high quality without close and constant supervision The plan of research submitted should be reasonable and concise and should indicate clearly the nature of the problem which the candidate wishes to investigate

Fellowships will be tenable for a period of two years and may be extended for a third year at the discretion of the Secretary of State Furthermore, Fellowships will be tenable in the British Colonial Empire only and not in the United Kingdom, the Dominions or India Application forms can be obtained from, and should be addressed to, in the first instance, to the Secretary, Colonial Research Committee, Palace Chambers, Bridge Street, London, S W 1

LATE PROF. P. N. GHOSH

As we are going to press we regret to announce the death of Dr P N Ghosh, Sir Rash Behary Ghose Professor of Applied Physics and Head of the Department, which took place on December, 23 at his Calcutta residence

ERRATA

November, 1946 issue

P 215, heading of Chart I—*For* "Mean Annual values (declination) *read* "Mean annual changes of declination" P 216, col 1, line 5, *for* "Mean annual values" *read* "Mean annual changes". P. 217, col. 2, line 2, *for* "five permanent observatories" *read* "four inactive permanent observatories". P. 221, col 1, line 21 *read* "treatments" *for* "treated ones" and on p. 222 in table 2, *read* "pennicillium" *for* "Pennicilium".

SCIENCE IN INDUSTRY

DISTRICT HEATING

It was as far back as 1877 that the first district heating installation was put up in Lockport, in New York, while in 1909, a District Heating association was formed in U S A In England although the earliest use of this system was made in Manchester in the beginning of this century, it fell into disuse and has been neglected considerably upto now. On the other hand progress has been rapid in other countries of Europe and America such as Detroit, New York, Indianapolis, Rochester, and Pittsburg in U.S A., Winnipeg in Canada and Hamburg, Berlin, Dresden, Kiel, Breslau, Karlsruhe and Frankfort in Germany In fact New York has largest installation in the world for dealing with district heating, where both the residential and business parts of the town are provided with heat "On Tap". Canada, and the Vatican City in Italy are also supplied with heat in the same manner, while Russia has no fewer than 160 heating plants in various cities, such as Leningrad, Moscow, Kiev, Kharkov and others

With a view to reveal the progress of the method of district heating in other countries and of its neglected state in England, a very interesting paper was recently read by Prof Reginald O. Kapp, Pender Professor of Electrical Engineering, University College, London, at the Institute of Fuel (*The Engineer*, Vol CLXXX, No 4694, December 28, 1945, page 534) According to the author of this paper, the advantages of district heating, *i.e*, supplying heat from a central source, could be divided into three main categories, *viz*, convenience, smoke abatement, and coal conservation The main convenience of this method lay in the fact that where district heating was available every room could be warmed by a radiator fed with steam or hot water, simply by turning a valve and regulating the temperature of the room. The open grates with their usual disadvantages would thus become superfluous. With the elimination of open grates or atleast a good deal of reduction in their working number, a considerable amount of smoke would be reduced This is evident from the fact that in England in 1937 over 15 per cent of the total amount of coal consumed was used for domestic heating, a use in which the maximum amount of soot was produced. According to the Royal Commission's Report (1935), in England the grand total of soot averages 3 million tons annually, of which the open grates, contribute the largest share. In discussing the question of coal conservation, Prof. Kapp also touched the problems of the cost of installations and the general economy of the system. As the domestic grate is an inefficient piece of apparatus the average efficiency of domestic coal consumers including open fires, stoves, and kitchen ranges, is only about 25 per cent. Central heating boilers have on the other hand, an efficiency as high as 80 to 85 per cent. Actually however when used for district heating systems their efficiency reduces down to 70 per cent due to heat and losses during transmission in pipes. Thus even this figure of 70 per cent compares very favourably with the thermal efficiency of 55 per cent in the case of central heating boilers for individual houses and 25 per cent for domestic coal consumers It is thus evident that district heating results in the conservation of the coal resources of a nation Going a step further the author shows that if the same boilers also serve an electricity supply, the national saving is even greater, because, whereas the thermal efficiency of a station that generates electricity only is rarely above 30 per cent, that of a station that generates both district heat and electricity is about 75 per cent to 80 per cent According to Prof Kapp, a station can use a given rate of coal consumption either for the generation of 100,000 K W of electrical energy alone, or about 80,000 K W of electrical and 180,000 K W of heat energy There is in consequence a saving in coal of more than one third if heat and electricity are produced from a combined station instead of from two stations A typical method of this combined generation has been described, by bringing into the picture the use of back pressure turbines, while the methods, of regulating the nature of supply and demand by balancing sources are also discussed

Among the limitations of the district heating system, mention is made of the fact that in England most of the houses have open grates and not radiators for space heating Thus while a saving in coal consumption can be expected from the use of a central heating system, the total economy is slightly reduced due to the additional cost involved in replacing open grates by radiators, which are a necessity of this system Another difficulty and a serious one as such is to know before-hand how to design the system for *i e*, the number of householders in a given district who are to become consumers. In the absence of these data, the size of boilers, of the diameters of pipes, and the amount of heat storage necessary, remain uncertain. Metering the heat consumed individually also forms—another problem,

Prof Kapp is however of the opinion that these limitations can slowly be reduced and even eliminated, once a country has advanced sufficiently in adopting district heating installations, as is exemplified in the cities of Europe and America With suitable modifications in the methods adopted abroad, the system of district heating, may well be worth considering in India, in the form of post-war development programme, as up to now this country does not appear to have taken up this question seriously and endeavoured to weigh the pros and cons of the problem

S K. G

AGAR AGAR FROM INDIAN *GRACILARIA*

Gracilaria confervoides, available in the salt water Chilka Lakes in the east coast of South India, is considered as a suitable raw material for the production of agar agar (*J Proc Inst Chem* India, *17*, 1945)

The process for preparing agar involves first in clearing and washing the weed and then extracting it with four times its weight of boiling water for about six hours The extract is filtered through cloth , poured into shallow enamelled tray and left in a refrigerator over night The frozen material is then thawed at about 10°C and the water decanted The solidified agar is cut into strips and dried in the sun Further purification, if required, may be effected by dissolving the material in hot water, decolorizing with charcoal, and freezing the filtered solution The agar thus produced is found to be satisfactory for culture media in bacteriological work and for use in the preparation of food products.

It is reported that on the recommendations of the Scottish Provisional Seaweeds Committee, the Treasury has authorized the expenditure of £5,000 for the purpose of carrying out large scale experiment in the collection and drying of seaweed at Loohmaddy, North Uist (*The Chemical Age*, November 16, 1946).

CRYSTALLINE PENICILLIN

COMMERCIAL production of sodium penicillin in crystalline form has been announced by the Commercial Solvents Corp , New York Special crystallization in the final production stage of the penicillin salt has made possible the production of the crystalline product, which has high potency and is heat stable Refrigeration during storage and shipping is thus eliminated The potency of the crystalline drug is of the order of 1400 to 1500 units per mg and it will be available in single vials of 100,000, 200,000 or 500,000 units It is white in colour and under a microscope the crystals are visible. Because of the increased purity, dosages as high as 200,000 units have been possible, as against dosages of 50,000 to 60,000 units with the former amorphous preparation (*The Chemical Age*, July 6, 1946)

INCREASE OF 16 PER CENT IN COTTON YIELDS

As a result of investigations made at the Agricultural Research Station at Koilpatti it has been estimated that there is an increase in cotton yields by about 16 per cent if the *Irungu Sorghum* crop, which is rotated with cotton, is mixed with indigo

Cumbu and *Irungu* are two types of Sorghum crops that are commonly rotated with cotton in the "Tinnies" tract comprising the three districts of Madura, Ramnad and Tinnevelly in the Madras Presidency Irungu is mostly grown as fodder for cattle

The yield of cotton following *Irungu* is less by about 16 per cent on an average compared to the crop following *Cumbu* The difference is due, among other reasons, to the increased sodium content in *Irungu* resulting in the alkalization of soil, particularly during the later stages of growth

To remove these ill-effects correctives like sulphur, gypsum and magnesite were tried but were found unsuited for rainfed conditions. Among several legumes experimented, indigo was found to be the best Indigo seeds can be mixed up to 12 lbs. per acre while sowing *Irungu*

MODERN SYNTHETIC FIBERS

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THE ability of the chemist and the chemical engineer to create from the test tube, through the factory, products that are often superior to naturally occurring materials is one of the outstanding achievements of this generation, and nowhere is it so remarkable as in the modern synthetic fibers. For, here is a group of synthetics which from a modest and gloomy beginning in the nineties of the last century have now grown to be one of the most abundant and successful of all textiles This growth is all the more remarkable when one considers that the natural fibers—cotton, silk, wool and flax—have been known and used for centuries Their growth is more through acceptance than by anything else—through their appeal to the consuming public on account of their own merits

The manufacture of synthetic fibers is an offshoot of the plastics industry rather than of textiles Today, an expert group of scientists and technicians are sufficiently familiar with the problems of both the groups—and an important branch of new science has developed out of necessity to control a product where a specially trained eye at each step of numerous intermediate stages are absolutely essential to produce our "fashions out of test tubes"

In nearly fifty years, rayon has successfully passed through an experimental stage in France, Germany, Japan, England, and U S. A to become a major textile fiber, and is exceeded in production only by cotton Just before Japan came into World War II, the per capita consumption of rayon in Germany was more than double that of the United States ; Japan and Italy, though they consumed less than Germany, were still ahead of U S A on a per capita consumption basis The total production of rayon staple fiber till 1940 indicates that Germany produced 8 5 times and Japan 6 times as much as the U. S A

The idea of creating synthetic fibers dates back to 1664, when Robert Hooke prophesied that "silk equal to, if not better than, that produced by the silk-worm will be produced by mechanical means". In 1754, the French scientist Reaumur concluded "Silk being nothing but dried up liquid gum, why cannot we make silk with gum and resin?" In 1855, Audemars, a Swiss chemist took out a patent for the conversion into filaments of a solution of nitro-cellulose In 1900, Blancher was working on discovering a chemical agent which would act as a substitute for the digestive processes of the silk worm and would transform certain constituent parts of mulberry leaf treated by special reagents He studied the structure and habits of the silk worm under the microscope and analyzed the mulberry leaf on which the silk worm feeds Finally a synthetic fiber was created which has revolutionized the textile trade of the world It was not silk The chemical analysis was not the same It was not even an imitation of silk It was a wonderful new fiber as beautiful in many respects as silk and, in some respects, more beautiful

It, however, remained for Chardonnet, a pupil of Pasteur, to focus and utilize the work of all who preceded him and to establish the first commercial unit for producing artificial silk in 1891. He worked out a method of transforming cellulose to a soluble colloidal form and converting it into thread But it was defective, as it was inflammable like gun cotton to which it was in many respects similar But his discovery paved the way for the present day rayon trade and, as such, he has been rightly called the "father of the rayon industry" He lived to see the commercial success of his labours before he died in 1924

RAYON

All synthetic fibers made from a cellulose base are known as rayon—the first in the field and still most important , but since 1930 many other types of fibers have been developed from easily available raw materials like coal, air and water or milk, soyabean and corn, through numerous different ways and means, each being a complicated process by itself understandable by the very best of chemists.

In the manufacturing of rayon, three methods are generally used · (1) The Viscose Process ; (2) The Cellulose Acetate Process , (3) The Cuprammonium Process A fourth one, the Nitro-cellulose Process—Chardonnet's original discovery—is now almost obsolete The Viscose and the Cuprammonium rayon is regenerated cellulose itself One starts with cellulose, treats it with a number of chemicals forming different intermediate substances one after the other, but ultimately regenerates the original cellulose again Chemically, it is the same cellulose but its physical appearance and properties have changed considerably One will never fail to distinguish between a rayon hose and a cotton shirt, however strongly the chemist may emphasize that both are the same.

Cellulose acetate yarn, however, remains a cellulose acetate in its finished state and not cellulose

The methods of making rayon by the three different processes differ widely in essential details, but the general principles of manufacture are the same and consist of three major steps

1. Cellulose is changed into a liquid form of suitable viscosity
2. The liquid is squirted through fine orifices and is drawn out into very fine streams
3. The liquid streams are changed into solid cellulose filaments and combined into continuous yarn, or made into short lengths

The Viscose Process The viscose process is the most important and accounts for a decidedly major percentage of rayon manufacture The process is due to two English chemists, C F Cross and E J Vevan who, in 1892, treated wood pulp with caustic soda followed by carbon disulphide to form a plastic cellulose compound readily soluble in water The name viscose was given because of the viscosity of the resultant solution made in this way Improvements since its discovery have been taking place in many directions, particularly in the coagulating bath and in the control of the ripening period of the viscous solution to bring it just to the right condition for spinning commensurate with strength of the resultant fiber But the greatest improvement has taken place in the making of the "spinneret"—a cap of precious metals with tiny holes, almost invisible to the naked eye The spinning solution is pumped through the holes in the spinneret, and as it emerges into hardening bath it coagulates into tiny filaments of regenerated cellulose, with its physical properties considerably changed It has now become silk-like Each hole in the spinneret forms an individual filament of yarn The number of holes in the spinneret determines the number of filaments, and the diameter of the holes determines the fineness of the finished yarn.

The Cellulose Acetate Process Next in importance in the rayon world is the cellulose acetate process discovered in 1869 by two German chemists Naudin and Schutzenberger They were, however, able to produce plastic sheets only Filaments from cellulose acetate solution were first made by Cross and Bevan and the making of a suitable yarn was perfected in 1899 by the German chemist Emil Bronnert.

The starting material is again purified cellulose, which is steeped in acetic acid and allowed to mature The aged pulp is then treated with acetic anhydride, a compound similar to acetic acid but from two of which a molecule of water is eliminated, and goes into solution as a new compound, cellulose acetate. On pouring water into these, the cellulose acetate is precipitated The precipitate is washed, dried, and then dissolved in acetone to form a spinning solution which is clear and as thick as molasses This solution as before is squirted through spinnerets, but the stream on issuing out falls through a shaft containing warm, humid air The acetone evaporates, leaving continuous filaments of acetate rayon

Cellulose acetate is a linear high polymer The long chain structure of cellulose is preserved in the acetylated product. A cellulose molecule accommodates the right type and right number of guests, eliminating, however, simple molecules of water as a result of its union Each glucose unit in a molecule of cellulose has room enough to accommodate three such guests, but a full house is too much a burden on it So it prefers to have less than three always Here lies the skill of the molecule engineer to produce a cellulose molecule containing the right number of stranger molecules Cellulose acetate displays the remarkable physical, colloidal and thermoplastic properties of a long-chain large molecule

The Cuprammonium Process The development of cuprammonium silk is due to the German chemist Schweitzer in 1857, who was successful in making a solution of cellulose in copper sulphate and ammonium hydroxide The yarn was first produced by a French chemist, Louis Henri Despaissis, in 1890, and the earliest commercial development was in Germany in 1897 This process has lost its competitive position with viscose rayon, and the reasons for this are not obvious It has definite advantages over viscose, for example, higher strength, lower viscosity of cellulose solutions, and no aging difficulties With improved methods of copper recovery, this method should be capable of producing rayon cheaper than by the viscose process, and work is in progress in this country to investigate on the better efficiency of copper recovery—a serious bottleneck in the process in the highly competitive field

The degree of luster in rayon is scientifically controlled, and is usually made in three types, a dull lusterless finish, a semi-dull and bright Rayon is stronger and usually much finer than natural silk which has been weighted in dyeing When wet the cellulose rayon yarns, with the exception of that made by acetate process, lose something over one half of the dry strength because of absorption of water and consequent swelling Cellulose acetate absorbs very little moisture because of its chemical composition and loses little of its dry strength when wet.

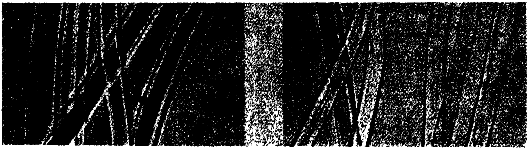
The absorption of moisture by viscose and other rayon yarns is considered a hygienic advantage for their use in underwear, those made from acetate yarn, however, claim the advantage of greater durability.

Garments made wholly or partly of rayon should be washed in lukewarm soapy water but not soaked The soap should be thoroughly rinsed out in lukewarm water, and the water squeezed out Boiling water, prolonged soaking, or rough handling when wet should be avoided.

Cellulose rayon yarns may be distinguished from real silk or wool by burning a few of the filaments and comparing the odour and ash with that of the real silk Silk burns much less readily and the odour is like that of animal products.

Cellulose, the solid part of the cell walls of plant life, is the basic raw material from which rayon is made Though cellulose is very plentiful in nature yet cotton linters and bleached wood pulp of certain types are only used for rayon manufacture, the reason being their abundance and consequent cheapness and the uniform quality of the cellulose obtainable from them Wood pulp is prepared with great care from selected materials and its quality is controlled by frequent chemical and physical tests one pound of yarn while the acetate process requires about 1000 gallons per pound of yarn The availability of such a quantity of water free from chemical impurities at a low cost is one of the controlling factors in the selection of a site for a rayon manufacturing plant Other utilities like steam, refrigeration, and electricity are also important considerations

The capital investment required for building up of a large rayon plant using any one of the known processes is very high and is of the order of rupees fifteen to thirty per pound of yearly capacity of the plant This coupled with the fact that the process of manufacture requires trained chemists and technicians to maintain a rigid control of every batch obviously necessitates an organization, the overhead expense of which will be large sums of money In consequence of this, only large scale production of the yarn is practicable and no small rayon plant is in operation anywhere in the world, as they will be easily thrown out of competition. At present rayon yarns are produced in U S. A , most of the European countries and Japan A comparatively new and promising industry has also been developed in Brazil



(a) (b)

FIG 1 Regenerated protein fibers (a) from the arachin of pea-nuts, (b) from the casein of milk (×250)

—With acknowledgment to *Endeavour*

The rayon industry also consumes great quantity of innumerable chemicals, chief among which are sulphuric acid, acetic acid, caustic soda, soda ash, sodium sulfate, ammonia, glucose, carbon bisulphide, copper sulphate, acetic anhydride, acetone and others These chemicals must pass rigid tests for uniformity and freedom from impurities which might affect the quality of the finished product

The economical operation of all the processes depends entirely on the recovery of as many chemicals as possible This is particularly true of acetate and cuprammonium process. Recovery of such chemicals like carbon disulphide, acetic acid, acetone, copper, ammonia and caustic soda is absolutely essential in an easy and economical way.

Another important factor, often overlooked, in the making of rayon is water. The viscose process requires 100—200 gallons of pure soft water to make

NYLON—VINYON—LANITAL—ARALAC

Since 1930, a unique class of synthetic fibers has been developed which starts with easily available materials other than purified cellulose Nylon, Vinyon, Lanital and Aralac are a few amongst many others which have gained commercial importance, and they have got certain remarkable properties unknown in rayon or natural silk

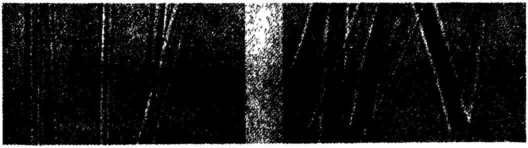
Nylon has been the sensation of the textile field because of its close approach to silk for hosiery and underwear and because of its unique elasticity and strength Although nylon generally refers to all "synthetic fiber-forming polymeric amides having a protein like chemical structure", it is commercially

the polymerized condensation product of adipic acid and hexamethylene diamine,—both can be obtained from benzene, a product of distillation of coal tar After the formation of the long chain linear polymer of desired chain length, they are remelted and extruded through spinnerets under nitrogen pressure into a stream of air, where they solidify immediately To impart the characteristic strength, the filaments are stretched by cold drawing which is supposed to "line up" the molecules so that they are parallel to the longitudinal axis of the fiber The filaments are then coated, twisted, sized, and, in the case of hosiery yarn, baked The resultant fiber is highly elastic and possesses a tensile strength greater than silk "Nylon wool" is made by cutting nylon filaments and treating them with steam or methyl alcohol vapour It has been successfully employed for warm clothing in Arctic climates DuPont Company of America is responsible for the commercial development of nylon early in 1940, and in 1942 all nylon fibers manufactured went into war uses

casein of milk The chemical similarity of casein and wool was long known, but not until Antonio Ferretti of Italy was able to solve the problem of making yarn from casein that commercial development has taken place

Lanital starts with milk which is coagulated with acids and the casein obtained is dried to granulated crystals This is dissolved in an alkali bath and allowed to ripen to a paste of proper viscosity This is then extruded through spinnerets into an acid-formaldehyde bath containing other addition agents also to increase strength and water resistance of the fiber

Lanital has greater warmth properties than natural wool and takes any color wool will take. The filament is highly crease resisting Its lack of resiliency and low wet strength make blending with wool desirable, and it is practically impossible to distinguish between the two except that casein fibers contain less sulphur.



(a) (b)

FIG. 2 Synthetic Fibers (a) Vinyon, (b) Nylon (×250)

—With acknowledgment to *Endeavour*

Vinyon yarn is truly synthetic in which ethylene from natural gas and chlorine from brine are the raw materials employed for its production From these basic materials vinyl chloride and vinyl acetate are prepared, the co-polymerization of which gives a white powder which can be dissolved in acetone The subsequent treatments are more or less similar to cellulose acetate yarn manufacture This was used for filter cloth and for similar industrial purposes where its low water absorption and resistance to chemicals constitute a particular advantage

Nylon and vinyon filaments are made out of simple molecules entirely by chemical means to yield the desired large molecules However, fibers have been successfully made from naturally available large protein molecules. Lanital and Aralac fibers belong to this class.

Lanital is the synthetic textile sometime described as "milk wool" or artificial wool and is derived from

Italy has led the development and production of casein base fibers during the past several years, but they were also manufactured commercially in Germany, Great Britain, Belgium, and Holland Under the name "Aralac", a similar product is now being manufactured in the United States. Also in this category of protein base synthetic fibers is "regenerated silk" which has been made in Japan and Germany by dissolving waste silk and spinning filaments from this solution

Many other protein base fibers are in the process of development and promise to be important in the near future Protein from soyabean is being converted into a textile in Japan and U. S. A., whereas Zein, a corn protein is also being tried in this country. Fish protein, waste animal skin and muscle tissue have been utilized in fiber production in Germany and Japan.

There are certain other types of fibers also which combine viscose with casein in the spinning solution and produce a tropical fiber with wool dyeing characteristics, and imparting some crease resistance

Fiber made from glass have found application where fire, heat and chemical resistance qualities are desired Fiber glass was prepared for wearing apparel as early as 1893, but recent development has taken place in producing a fiber of extremely small diameter. Glass staple fiber is produced by flowing molten glass through a high pressure steam jet The fiber glass is of great strength and high corrosion resistance.

A textile fiber has also been produced experimentally from chlorinated rubber.*

Here the story of silk pauses—not ends. It began ages ago with a humble worm in far eastern China and has reached its climax on the western hemisphere in the greatest silk mills in the world—not by playing with the life history of the worms, but by the ingenuity of chemistry, and is largely responsible for the ability of the fair-sex to dress so well today

* Recently word came from England that a rayon has been developed from alginic acid, obtained from dry sea weeds which contain about 15-40% of it.

MEDICINE AND PUBLIC HEALTH

TUBERCULOSIS IN INDIA

DEATHS in India from tuberculosis, which numbered 500,000 a year before the war, are nearly double that figure now and it is estimated that there are five infections to every death In industrial areas like Cawnpore the death rate has become very high

Despite this, there are only 6,600 hospital beds available in the whole of India for tubercular patients ; 70 sanatoria and hospitals and 124 clinics

A news from Sweden State that this dreadful desease is definitely being brought under control by the use of B C G vaccine This vaccine, first introduced by two French workers, as a specially bred type of bovine tubercle bacillus which is administered live as a vaccine It is claimed that if the present tendencies are maintained, tuberculosis will have ceased to be a killing disease in Sweden by 1960

Active steps are being taken to introduce and produce in Britain B C G vaccine If the results are convincing, the vaccine with whatever its initial cost, should be made available to India as well

DRUGS ACT, 1940

REALIZING the serious situation arising out of the indiscriminate adulteration of drugs and chemicals in India, the Government of India appointed a 'Drugs Enquiry Committee' in 1930-31, with Lt Col Sir Ram Nath Chopra as its Chairman This Committee recommended :

(1) A drugs and pharmacy legislation on the lines of those existing in Great Britain and America, and

(2) The establishment of a standardization laboratory, to test and analyse the products and give authoritative opinion on the quality and potency of the drugs manufactured, imported and distributed for sale in India.

Pursuant to the above recommendations, 'The Drugs Act, 1940' (Act No 23 of 1940), received the assent of the Governor General on the 10th April, 1940 The implementation of the act, however, could not be given effect to owing to the war The Government of India, have now published a set of detailed rules under the Drugs Act, 1940 (see *Gazette of India* dated 22-12-1945) and it is contemplated to enforce these rules from 2nd February, 1947

This would involve the setting up of Central and Provincial Standardization Laboratories and an inspectorate charged with the duties of invigilation of drug manufacturing and distributing centres, that would ensure the quality and potency of the medicaments

SEX-RATIO OF BIRTHS IN INDIA

DISCUSSING the question of more boy-babies being born in Bengal than girl-babies Mr J. M Datta (*GENUS*, Vol V., No. 304 December 1942, the Journal of the Italian Committee for the Study of Population Problems published from Rome and just received in India) has confirmed the Hofacher-Sadler Law of Masculinity at birth being greater among the first-born from the Bengal statistics. Jastrzebski's conclusion that masculinity is greater in rural than in

urban populations has been negatived by Bengal figures. Rather the contrary is the case Masculinity at birth in Calcutta is greater than in municipalities; and that in municipalities is greater than that of all Bengal.

Mr Datta has further shown that masculinity at birth is slowly increasing in Bengal with some periodic fluctuations; and has found that there is no close relation between increasing urbanization and the growing masculinity.

PROCESSED OIL-SEEDS AND SEED-CAKES AS ARTICLES OF HUMAN FOOD

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DURING recent years several attempts have been made to find out suitable substitutes for yeast products The possibility of using groundnut and groundnut products as sources of food protein and vitamins has been engaging our attention for some years. More recently, we have also investigated the possibilities of using other seeds and seed-cakes

A great deal of work has been done on the nutritive value of protein from yeast and groundnut The following is the normal range of the gross protein contents:—

Dried yeast	40-55%
Groundnut cake	50-58%
Whole groundnut	24-31%

Groundnut cake is thus as rich as yeast in its protein content. A comparison of the amino-acid composition of the two proteins reveals that except for lysine, which is rather high in the case of yeast, the other amino-acids are present in practically the same proportions in the proteins of groundnut and of yeast.

Source of protein	Coefficient of digestibility	Biological value (Balance sheet method)	Biological value (Growth method) 8% level
Groundnut protein	97 4[1]	57 8[1]	1 45[3]
Yeast protein	83 0[2]	52-61[2] (for solubles)	1 48[4]

[1] Mitchell *et al*, 1936.
[2] Hughes and Hague, 1945
[3] Maynard *et al*, 1923
[4] Kon and Markuze, 1931.

Judging from the biological value of the two proteins, groundnut is at least as good as yeast.

Backel (1942) observed that the biological value of yeast protein is much inferior to meat, egg and milk proteins. Experiments on men, pigs and rats showed that the biological value of yeast protein was of the same order as that of vegetable proteins.

Feeding experiment with rats—That groundnut proteins is of good nutritional quality is confirmed by feeding experiments on rats Jaquot and Roandoin (1942) have shown that groundnut meal proteins are quite as good as yeast proteins for promoting the growth of young rats According to Baernstein (1937-38) the proteins of groundnut are approximately equivalent to casein in promoting the growth of rats when fed at 20% level Conarachin, which is one of the proteins present in groundnut is found to be an excellent protein for growth when fed as the sole source of nitrogen. Jones and Divine (1944) also have shown that groundnut proteins, besides themselves possessing a high nutritive value, enhance the growth promoting value of the proteins of wheat Groundnut cake is thus an excellent supplement to wheat flour.

On the other hand, recent researches carried out on the value of yeast as a source of protein indicate that the protein is deficient in certain essential amino-acids and, as such, it is not a good protein of high nutritive value. Klose and Fevold (1944) found that samples of Brewer's yeast and Torula yeast failed to support even moderate growth when fed as the sole source of protein to growing rats This has been traced to the deficiency of the protein in the essential amino-acid, methionine Recently Chick and Stack (1945) have shown that the nitrogenous substances in yeast, when employed as sole source of nitrogen in an otherwise complete diet, supported growth of young rats at a rate much inferior to that of litter-mates on a diet containing the mixed nitrogenous substances derived from whole wheat flour

From the foreging it is evident that groundnut is not inferior to yeast as a source of food protein.

YEAST *Vs* GROUNDNUT AS SOURCES OF VITAMINS

The greatest merit of yeast lies in its high B vitamin content, but its potency in regard to the various

vitamins differ according to the strain of yeast and the nature of the medium used for growing it. Groundnut is also a very rich source of vitamin B_1 and nicotinic acid. The following table based not only on our observations but also those of other workers would show the value of groundnut compared to yeast as a source of vitamin B_1 and nicotinic acid. The riboflavin content of groundnut is however not so high as in yeast.

	Vitamin B_1 (per gm 100 gms)	Nicotinic Acid (mg /100 gms)
Groundnut flour (defatted)	600 2,000 (200—660 I U)	16—22
Yeast (dry)	500—4,000 (155 1,330 I U)	12—50

The Availability of Vitamins from Yeast and Groundnut

Recent investigations on the absorption of thiamine by human subjects from various types of baker's yeast (Parsons *et al* 1945) have indicated that the samples fed fresh to human subjects were poorly utilised as sources of B_1 as indicated by a low urinary and a high faecal elimination of the vitamin. The ingestion of these yeasts appears even to have decreased the amount of available vitamin B_1 supplied by the basal diets. Our investigation on groundnut cake as source of vitamin B_1 have shown that the vitamin contained in groundnut is completely utilised by experimental animals (Reddy and Giri, 1946). Experiments with human subjects will soon be taken up.

Yeast Extracts *Vs* Predigested Groundnut Cake Products

Although groundnut has the composition of a first class food material, it has not been generally popular as an article of human food, because it is lacking in certain essential qualities. Groundnut, as a whole, is known by common experience to be poorly digested in the human system. This is partly due to the fact that nut meats are not broken into small enough particles in the process of chewing. The cake powder is coarse, containing varying amounts of oil (which may often be rancid), skin, husk, dirt and sand. Many samples of cake are moist, fungus grown and insect infested. Small quantities of the cake powder can be admixed, as such, with *atta* and different other articles of food, but its presence is usually noticed by a large section of users. The general experience is that the addition of the cake makes the food materials rather 'doughy' and that consequently they are difficult to digest. Cases of diarrhoea resulting from the use of groundnut, either as a whole or as cake powder, have been reported by the health authorities. It is important, therefore, that if the best use is to be made of groundnut in any form, it should be freed from roughage and grit and pre-digested or otherwise processed so as to increase its utilisation in the human body. If the proteins are broken down by enzymes outside the body, they would be more completely utilised. If we are to take full advantage of this important protein food, it is necessary to find out suitable methods of processing the flour with a view to making it more palatable and digestible.

Investigations for the last three years carried out in this laboratory on the development of methods to produce predigested and concentrated protein products from groundnut cake have provided ample evidence to show that these products resemble yeast extract such as marmite in several respects. The bulk of the proteins and vitamins originally present in the cake are retained in the final product. The results of chemical analysis of the predigested protein food from groundnut cake together with those of marmite and other yeast extracts are tabulated below —

No	Constituent	Predigested protein food from groundnut cake	Marmite	Other yeast extracts
1	Water	25 7%	26 84%[1]	.
2	Total nitrogenous extractives	60 8%	34 67%[1]	27%-43%
3	Peptones and amino acids	14 4%	10 50%[1]	
4	Ether extractives	0 24%	.	
5	Phosphorus	0 336%		
6	Calcium	0 068%		
7	Iron ..	0 0064%		
8	Vitamin B_1	260-330 I.U / 100 gms	200 I U / 100 gms[2]	160-440 I U 100 gms[4]
9	Nicotinic acid	290 μg per gm /gm	640 μg per gm[3]	285-470μg per gm / 100 gm[5]
10	Riboflavin	Not estimated	6 mg /100 gm[1]	.

[1] Hutchin's food and the principles of Dietetics, 1941, and figures supplied by manufacturers.
[2] Leong, 1940
[3] Kodicek, 1940
[4] Harris and Wang, 1941
[5] K Bagavat, 1943

Utilisation of other seed-cakes.—Experiments with other edible seed cakes have shown that they could be processed in the same way as groundnut cake to yield quite palatable concentrated digests, which are also easily assimilated. Sesame cake has the additional attraction that it is naturally rich in

calcium. Cotton-seed hydrolysate is also a pleasing product with a good taste and flavour Further work along these lines is in progress not only with a view to extending the technique of predigestion, but also to comparing the nutritive values of the resulting products Experiments with both animals and human subjects are in progress and the results will be published at an early date

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BOOK REVIEWS

Weather Study—By David Brunt, F R S, Professor of Meteorology, Imperial College, South Kensington, published by Thomas Nelson and Sons Ltd, London, p 215 Price 5*s* net

This book forms one in Nelson's Aeroscience Manuals The author who is a leading meteorologist states on the preface that his aim in writing the book was to provide a simple text book of meteorology suitable for readers with little or no previous knowledge of the subject He had particularly in mind the needs of Air Force Cadets and others whose interest is largely aeronautical. The book is meant to be helpful to students of Geography whose course of study usually includes the elements of Meteorology, and to students of Radio-location In this little book Dr Brunt has described the main facts of meteorology in very simple and straightforward language avoiding mathematics as far as possible It might be said to be easy version of its bigger brother, Brunt's dynamical meteorology The treatment is easy and simple, masterly, and covers almost the whole ground I recommend the book not only to the class of students for whom it is meant but also for a much wider circle.

M N S

Asiatic Jones—By A J. Arberry, D.Litt, Pp. 40, with 9 illustrations including a colour reproduction of the portrait by Sir Joshua Reynolds Longmans Green & Co. Ltd., 1946. Price 2*s*.

The recent commemoration of the bicentenary of the birth on 28th September of Sir William Jones (1746-1794), the great pioneer of oriental studies is appropriately followed by this scholarly essay written by Prof Arberry of the School of Oriental and African studies, University of London The author has within a short compass surveyed the remarkable work which Jones did in opening up for the benefit of the west the rich fields of Indian civilization, art and philosophy The facts are based partly on unpublished contemporary material, the originals of which are preserved in Farl Spencer's library and the author was able to consult these owing to the kindness and generosity of the present Earl Spencer.

The author has further impressed the influence of oriental culture in 19th century English Literature The brochure serves as a supplement to the author's previous work entitled "Persian Jones" (*Asiatic Review*, Vol 9, April, 1944)

A K G.

Introduction to Optics—G. B Deodhar, Ph D (London). Pp xiv+617, 21 plates The Indian Press Ltd, Allahabad, 1945. Price Rs. 12/-.

This book was originally published in 1936 and in this second edition some of the chapters have been revised. The book is intended to serve as a text-book of optics and the standard is that of B Sc Honours course of most of the Indian universities Besides dealing with topics on geometrical and physical optics, it also includes chapters on optical instruments, spectroscopy, rainbows and photometry. Such a combination of varied topics in a single treatise is hardly found in other text books available in India, conforming to the standard mentioned above.

The chapters on geometrical optics include discussions on properties of thick lenses and lense combinations, various defects in images formed by reflection and refraction at spherical surfaces and chromatic aberration Experimental methods of determining optical constants of mirrors and lenses have also been given The chapter on optical instruments has been made highly interesting by including in it illustrated discussions on telescopes used in astrophysical work, ultra-microscope and refractometers, besides those on common optical instruments The chapter on interference of light, besides dealing with typical interference phenomena, includes discussions on Jamin's and Michelson's interferometers, Rayleigh's refractometer and Michelson's stellar interferometer Discussions on Fabry-Perot *et al* on and Lummer-Gehrcke plate are included in the chapter on diffraction, but these are too brief to be useful There are some remarkable features in the chapter on diffraction of light, *e g*, various methods of mounting a concave grating have been explained and the resolving powers of prisms and microscopes have been discussed along with that of a grating. The reproductions of some beautiful diffraction patterns have made the chapter all the more interesting The chapter on polarisation describes the properties of uniaxial and biaxial crystals and different methods of studying polarised light, but no analytical treatment of the phenomena is given. The chapter on optical phenomena in earth's atmosphere includes fairly thorough discussions on formation of rainbows and brief discussions on halos, scantillation of stars and Aurora Borealis The chapter on spectroscopy deals with dispersion, both normal and anomalous, spectrometers of various types for studying the different regions of the spectrum and Bohr's theory of atomic spectra. Chapter XVI dealing with absorption colour and transformation of radiations includes brief discussions on the Compton effect and the Raman effect and the next chapter on scattering deals very briefly with Rayleigh scattering and allied natural phenomena. The chapter on photometry gives descriptions of a large number of photometers including modern microphotometers There are 8 appendices giving methods of silvering and sputtering, and optical and other physical constants

This book will probably remove a long felt want of a suitable text book for the B.Sc Honours students. Considering the number of plates and illustrations and also the size and number of pages the price seems to be highly moderate, if not too low

S C S.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

THE FERTILISING VALUE OF A SOLID PRODUCT PREPARED OUT OF CANE MOLASSES

ALTHOUGH the production of power alcohol is one of the best possible uses of cane molasses, it is not always feasible, especially when the sugar factories are small and situated far apart from each other Under such conditions, other possible uses must also be considered, especially when there is scope for converting the molasses into a solid product which could be easily handled and transported

The present authors have demonstrated the possibility of converting molasses into a solid product[1] by treating it with burnt lime in the proportion of 1 part of lime to 3-6 parts of molasses, depending upon the quality of the lime. The reaction is extremely rapid and takes place with considerable evolution of heat The resulting product, which sets to a solid on drying can be easily powdered and used as a fertilizer It is very efficient in fixing atmospheric nitrogen, but as the fixed nitrogen is not very stable[2, 3], the following trials were carried out.

The experiments were carried out on a uniform piece of land which was ploughed up and divided into four blocks ; each block had 12 plots, each plot measuring 15 feet by 10 feet The various treatments were distributed according to the 'randomised block' arrangement with four replicates for each treatment.

The manures and fertilizers were applied on equivalent nitrogen basis. In the case of molasses and the molasses-lime product, the quantities were calculated on the basis of nitrogen which would normally be fixed in the soil on the application of these materials[4, 5]. The necessary amounts of molasses (108 lbs. per plot at the rate of 21 tons per

acre), the molasses-lime product (154 lbs. per plot at 30 tons per acre), hongay cake (15 2 lbs per plot at 3 tons per acre), ammonium sulphate (3 04 lbs per plot at 0 6 ton per acre), straw powder (5 lbs per plot at 3·7 tons per acre) and powdered lime-stone (7 lbs per plot at 7 5 tons per acre) were applied to the soil 4 weeks before the crop was planted (excepting ammonium sulphate which was applied as top dressing). Two weeks after these basal treatments, superphosphate was applied to all the plots (excepting the unmanured control set) at the rate of 400 gms per plot.

Ragi (*Eleusine coracana*) was the first crop raised after the above treatments of the soil The ragi seedlings were transplanted at the rate of 350 per plot and they were subsequently thinned down to 300 per plot The yields of ragi straw and grain obtained from the different sets of plots are recorded in Table I Jowar was raised in the subsequent seasons in order to determine the residual effects of the various treatments of the soil The data relating to jowar are also given in Table I.

TABLE I

THE RESULTS OF PLOT EXPERIMENTS

Treatments	Wt of ragi straw in lbs: Before drying	Wt of ragi straw in lbs: After drying	Wt of ragi grain in lbs	1st season residual effect (wt of fresh jowar in lbs)	2nd season residual effect (wt of fresh jowar in lbs.)
1 Molasses alone	17 0	9 0	9 9	411 0	80 0
2 Molasses + straw	26 0	15 8	11 3	452 0	136 0
3 Molasses-lime product alone	32 0	20 0	16 5	548 0	130 0
4 Molasses-lime product+straw	28 0	16 5	14 3	498 0	120 0
5 Hongay cake alone	42 0	27 0	21 0	375 0	136 0
6 Hongay+straw	40 0	25 0	14 7	366 0	104 0
7 Ammonium sulphate alone	56 0	31 0	20 8	296 0	94 0
8 Ammonium sulphate+straw	58 0	34 0	22 1	322 0	98 0
9 Straw alone	16 0	10 5	7 5	334 0	118 0
10 Limestone (Cal carbon alone)	23 0	14 5	11 2	369 0	82 0
11 Straw+limestone	15 0	10 5	8 0	377 0	96 0
12 Unmanured control	14 0	9 5	7 8	314 0	121 0

It was observed that, after application of both molasses-lime product and hongay cake, the soil required rest for over a month , otherwise there was an initial depressing effect Subsequently, the general growth and crop yield showed distinct improvement. There was also pronounced residual effect which could be seen in the second crop, molasses-lime product giving the highest yield.

In the above experiment, both molasses and molasses-lime product were applied at comparatively high levels rarely adopted in India. If used at a distinctly lower level, say, 3-5 tons per acre, the soil will require much less rest. The crop response at this level will also be of much practical interest.

The authors thank Prof V Subrahmanyan for his keen interest in the work

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A NOTE ON AN ARCHAEAN TRACT IN THE PALAMAU DISTRICT, BEHAR

THE tract covers an area of nearly 50 sq. miles round about the village Chandwa in the Daltonganj sub-division of the Palamau district. The nearest railway station, Tori, is situated at a distance of about three quarters of a mile from Chandwa No economic mineral deposit was found but limestone, hematite, graphite, and bauxite is said to exist beyond the boundaries of the area examined

The place is more or less a hilly country, the hills ranging from 1,000 to 3,000 ft. in altitude At the south-west corner there is a zigzag pass through the hills, which is called Torighat. The area was first surveyed by Ball in 1878 in connection with the iron ore deposits of the place but he left out the metamorphics which is the subject of this note.

The area surveyed is almost wholly covered by archaean rocks, comprising Pink granite gneiss, and

Amphibolite types mainly. The geological succession of the area is as follows

Alluvium—	..	Sub-recent
High level laterite		
Pink granite gneiss		Archaean
Amphibolite		

Following is the description of the various rock types·

Amphibolite.—This is a dark variety of rock consisting essentially of hornblende and plagioclase and a few accessories like apatite, biotite, magnetite, and chlorite, a secondary alteration product of biotite and hornblende It has a non-schistose and more or less equigranular structure.

Pink Granite gneiss —A leucocratic rock rather pinkish in colour as seen in hand specimens and consists essentially of quartz, microcline, orthoclase and biotite and the accessory minerals apatite and allanite Secondary alteration products are kaolin and sericite derived from the felspars Myrmekitic structure are also to be found in some thin sections of this variety The rock is coarse grained, holocrystalline and hypodiomorphic in character and also shows some parallel arrangement of minerals

Intermediate types (hybrid rocks) —These consist essentially of biotite, orthoclase, plagioclase and hornblende Accessories are apatite and sphene Chloritization of hornblende and biotite and sericitization of the felspars are common Banding of the constituent minerals are apparent both in the hand specimens as well as in thin sections Myrmekitic structure is also sometimes present

These rocks were produced by the interaction of pink-granite-gneiss and amphibolite, the evidence of which is indicated by the change of hornblende to biotite, a mineral just below the hornblende in reaction series and also by the presence of minerals common to both of the former types

Calc-silicate rocks —In thin sections diopside is seen, the origin of which is due to the thermal metamorphism of some pre-existing impure calcareous rocks

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NOTE ON A CLASS OF SOLUTIONS OF EINSTEIN'S FIELD-EQUATIONS IN AN ELECTROSTATIC FIELD

IN my last note it was shewn by me that a wide class of electrostatic fields can be represented by the line element

$$ds^2 = -e^{-w}(dx_1{}^2 + dx_2{}^2 + dx_3{}^2) + e^{w}dt^2 \quad . \quad . \quad (1)$$

where $$e^{w} = \tfrac{1}{2}(\phi \pm \sqrt{2})^2 \quad . \quad . \quad . \quad . \quad (2)$$

$\phi/\sqrt{8\pi}$ being the electrostatic potential in Lorentz units It was further shewn that the associated function v given by

$$w = -2 \log (1+v)$$

satisfies Laplace's equation

It may be pointed out that the line element (1) where the spatial dimension appears as isotropic is the most general line element possible under the circumstances For, if we take the line element in the general static form

$$ds^2 = g_{ab}dx_a dx_b + e^{w}dt^2, \quad (a,\ b = 1,\ 2,\ 3)$$

and introduce a set of functions $/g_{ij}/$ defined by the equations

$$g_{ij} = -e^{-w}/g_{ij}/, \quad (i,\ j = 1,\ 2,\ 3)$$

$/g_{ij}/$ being the metric tensor of an associated three-space conformal to the actual space, then it can be shewn by substitution in the field equations

$$G_{ij} = -8\pi E_{ij} \qquad (i,\ j = 1,\ 2,\ 3,\ 4)$$

that subject to the relation (2)

$$/G_{ij}/ = 0 \qquad (i,\ j = 1,\ 2,\ 3)$$

in the associated three-space Since in *three*-space the vanishing of the contracted Riemann tensor implies the vanishing of the Riemann tensor itself, we arrive at the conclusion that the associated three-space is Euclidean This shows that (1) is the most general static form of line-element compatible with the relation (2)

Complete calculations will appear in due course

My thanks are due to Prof. M. N. Saha and Prof. N R Sen for their kind interest and encouragement in the work

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DELHI—OLD AND NEW

DELHI where the Indian Science Congress meets for its thirty-fourth session under the aegis of the first National Government claims an antiquity far beyond the ken of history According to the ancient epic, the *Mahabharata*, it marks the site of *Indraprastha* which was reputed to be founded by the Pandav Brothers, and it was the place where the eldest of them, King-Yudhisthira performed the Rajasuya Ceremony which marked assumption by him of Sovereignty of the whole of greater India The *Puranas* (ancient chronicles) would make us believe that this event took place in 2400 B C, but the epic itself appears to have taken shape between the fifth and second century B C, and it relates the incidents in such a romantic and confused way that it is difficult to place any credence either on the events narrated, or on the date suggested

Buddhist traditions of the first and second century A D talk of a line of Kuru princes reigning at Indraprastha The kings of Indraprastha are given the stock name of Dhananjaya Korabya, which is the name of the third Pandav brother, and his minister is called Bidur, who is the good uncle in the epic. There is no improbability in the place having very early attained commercial and political pre-eminence, for the city occupies a unique site, being protected by the ridge and the Jumna river, and situated on the main trade route between the two important river systems of the Punjab (the Indus and its tributaries), and the Midcountry (the Ganges and its tributaries) Popular belief identifies the mound on which Sher Shah built his fort with Indraprastha where Maya, the Danava architect, is said to have built a splendid palace and court for the Pandava princes The tradition in any case is fairly old and goes as far back as the Tughluq days But no relic of the epic age has, it is true, been so far discovered, but the secrets of the site still await the explorer's spade Who knows if some future Schliemann might not some day uncover here some relics of the alleged Pandava times While such an exploration would be very desirable, it is desirable to demolish some of the current beliefs

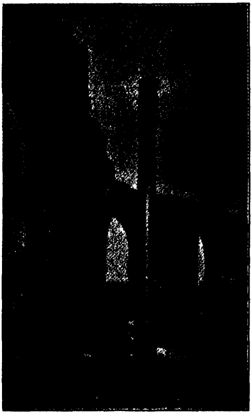
The masonry work in which the credulous visitor delights to discover the ruins of Draupadi's kitchen is nothing but the remains of a Muslim *hamam* (bathroom) and the temple associated with Kunti's name is a very modern structure. But the mound itself would be an ideal place for a pre-historic settlement and similar antiquity has also been claimed for the present sites of Nigambodhghat and the near-by temple known as Nili Chhatri How long Indraprastha or Indrapat enjoyed its alleged imperial glory, why was it ultimately abandoned and when did it relapse to obscurity we do not know.

The earliest monuments now found in Delhi did not originally belong to this city In the Mauryan days, Indrapat had evidently yielded place to Meerut and even to Topra, now an unimportant hamlet near Ambala When Asoka set up his stone pillars at different centres of India the old Pandava capital did not commend itself to his consideration and Meerut and Topra were preferred instead But the two monoliths were not destined to remain there for ever Sultan Firuz (1351-1388) of the House of Tughluq transferred to his capital and placed them in two different quarters of the new city of Firuzabad, one on the roof of a specially designed building within the compound of his fortified palace and the other at the far end of the city on the ridge near his hunting box The Delhi-Topra pillar is of special interest to archaeologists as it bears the full complement of the seven pillar edicts besides a Rajput inscription of warlike tenor The Delhi-Meerut pillar was broken into four pieces It has however been repaired and re-erected on the site selected for it by Sultan Firuz (Kotla Feroj Shah)

THE IRON PILLAR

The next in chronology as well as in interest is the famous iron pillar in the court yard of the Quwwat-ul-Islam Where it originally stood we do not know for certain It bears an inscription in Gupta script that testifies to the valour of one king Chandra One feels inclined to identify this monarch with the warrior king of the same name (Chandragupta II, Vikramaditya of the Gupta Dynasty *ca* 380-413 A D) who held the major part of northern India in fee during the 4th century A D, but positive proof is lacking and the identity of this great conqueror still remains a subject of controversy. According to Dr Murray Thompson, the shaft is made of "pure malleable iron of 7·66 specific gravity" On account of its antiquity, and absence of rust in spite of exposure in the open air for thousands of years, the iron pillar has become the object of research by such famous metallurgists as Sir Robert Hadfield Like the monoliths of Asoka the iron pillar has lost the

figure on its capital if it ever bore one A Rajput inscription on the iron pillar throws some light on the history of Delhi.



IRON PILLAR, DELHI

FOUNDATION OF DELHI

When did the present city of Delhi inherit the glories of Indrapat? When was it founded? Al-biruni knew it not (1020 A D) and the place apparently was not important enough to excite the cupidity of Mahmud of Ghazni Utbi, historian of Mahmud of Ghazni, was unware of its existence, but the Rajput epigraph mentioned in the preceding para says that Anangpal of the Tomar family peopled Dihali about 1052 A D Delhi passed under the Chauhan ruler of Ajmere, Vigraharaja IV, sometime berfore 1064 A.D. and it was from his nephew Prithviraj, Rai Pithora of Muslim historians, that Delhi was conquered by Mohammed bin Sam in 1193 A.D. Two records of 1826 A.D assert that the line of Prithvi Raj was not extinct till then. It may therefore be safely assumed that Delhi rose to prominence under the Tomar and the Chauhan princes. Probably an earlier Rajput settlement had flourished around the present ruins of Suraj Kund but in course of time the head-quarters of the reigning family was shifted further north. Since then Delhi has been moving north and east Only twice was the order reversed, once when the founder of the Tughluq monarchy preferred an isolated rock to the plain below, and again when the British Government decided to build their new city south of Shahjahanabad.

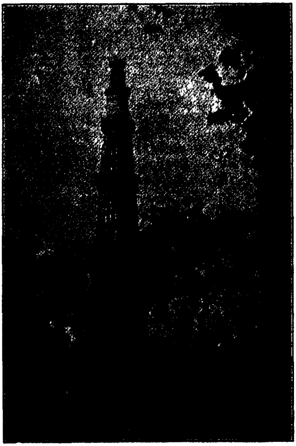
QUILAH RAI PITHORA, THE EARLIEST MOSLEM CAPITAL

When they overthrew the Rajputs, the Turks chose for their capital the city of their adversaries Quilah Rai Pithora was strengthened and within its circuit were built the famous white palace of Qutb-uddin Aibek (1206-1210), the turquoise palace of Shams-uddin Iltutmish (1211-1236) and the green palace where the God-fearing King Nasir-uddin Mahmud Shah (1246-1266) held his Court Delhi was then a busy city humming with trade and throbbing with life Traders used to come here from far off cities of Central Asia and soldiers came in hundreds from all parts of the Muslim world in quest of adventure, fame and fortune But the splendid palaces and superb private mansions were far surpassed in grandeur and beauty by the cathedral mosque which the first Muslim Sultan dedicated to the glory of his faith Quwwat-ul-Islam was a living symbol of the might of the new force which impelled the Turks to carry its banner further east and south and piety of successive monarchs added new arches, fresh towers, cloistered courts and domed gateways to the original mosque Qutb-uddin built in a hurry and twenty seven Hindu and Jaina temples were pulled down to furnish materials for a prayer hall worthy of the conquerors The pillars still bear all the signs of their origin and sculptured representations of men and animal forbidden by the Quran tell their own story On some of the pillars are found female figures mounted on lions, on others will be noticed human faces and Kirtimukhas The Muslim overseers who supervised the work of Hindu masons and workmen had no time to efface from the stone slabs the figures of Brahma, Vishnu and Shiva and some of them still retain sculptured depiction of scenes from Krishna's life But for the *mihrabs* the mosque at first lacked all the characteristics of a Muslim place of worship until an arched screen was built by Qutb-uddin, and Iltutmish and Allauddin Khalji (1295-1315) contributed to its extension Quwwat-ul-Islam is now in complete ruins but parts of the lofty arches still remain as a testimony to its vanished grandeur. Within the holy precincts sleep Iltutmish and Allauddin, two of the greatest military leaders that Medieval India ever produced, and not far off from the mosque stands the tomb of another Sultan, Ghyasuddin Balban (1260-1285), great alike in peace

and war. The walls of Iltutmish's tomb are sumptuously sculptured but the dome they once sustained is gone. A similar fate has overtaken Allauddin's madrasa and his tomb but the superb domed gateway that the Khalji monarch built still survives. It is most elaborately ornamented and its horse shoe arches offered marked contrast to the pointed arch of the main cathedral. The Alai Darwaja can be seen to the greatest advantage in the light of the morning sun. Outside Allauddin's gate, not ten yards from it, is a lovely little tomb which Imam Zamin, a contemporary of Sultan Sikandar Lodi (1489-1517), built for himself, and very near the Alai Darwaja, to its north stands in its solitary grandeur the lofty minar that goes by the name of Qutb

The Qutb-Minar

Two hundred thirty eight feet in height, the minar is divided into five storeys Its history is to be found in its inscriptions According to Sir Syed



Qutb Minar, Delhi.

Ahmed, one inscription runs as follows: "Amir of Amirs, Commander in Chief, the Chief in the State, Qutb" Two inscriptions refer to Muhammad bin Sam. Two other epigraphs assert that the building was commenced and completed by Iltutmish's order. Yet other two refer to the repair and restoration of the minar by Firuz Shah bin Raj (1351-1388) and Sikandar Shah Lodi (1489-1517) There is reason to believe that the two top most storeys were entirely rebuilt by the Tughluq ruler as they differ in style as well as material from the rest of the tower. If General Cunningham's reading of the *nagri* inscriptions is accepted, Firuz Shah had employed a Hindu architect in repairing the minar when it was damaged by lightning in 1378 A D. Firuz Shah had furnished the minar with a cupola which was in existence till 1794 In 1803 Major Percy Smith built another superstructure which appeared so grotesque that Lord Hardinge ordered its removal in 1848 It is now to be seen in the lawn near the Dak Bunglow. Such in short is the story of the tower which Fergusson judged to be "the most beautiful example of its class known to exist any where "

Was it a tower of victory? Or was it an adjunct of the neighbouring mosque, a ma'zina wherefrom the ma-azzin used to summon the faithful to prayer at specified hours? Probably it served both purposes A tower built so near the mosque, copiously embellished with Quranic texts, could not but share the sacred character of the neighbouring edifice, but its very height rendered the upper storeys superfluous for the Mu'azzin's purpose, though they served very well to illustrate and emphasize the superior might of the power against which Rajput daring and chivalry had proved of no avail

Who gave this unique tower its name, Qutb, the King, or Qutb the saint? If the King's name finds a place in one of the inscriptions, the saint was the preceptor of the Sultan under whom the minar was completed In popular estimation probably the saint was a greater personage than the soldier, for he was believed to have been endowed with supernatural power Qutb-uddin Bakhtiyar Kaki came from Ush in Central Asia He was a disciple and the apostle successor of Sheikh Muinuddin Chisti The shrine of Qutb Sahib has afforded two of the *roi faineants* of Delhi, Shah Alam II (1761-1806) and Akbar II (1806-1837), their last resting place. A third would fain sleep here but fate decided otherwise. Bahadur Shah II, the last titular Timurid emperor of Delhi died an exile at Rangoon (1862) after his abortive leadership of the Sepoy Mutiny, now called the first War of Indian Independence. It will be wrong to suppose that only puppet kings sought the protection of so potent a saint The first Shah Alam (1707-1712) lies buried in Qutb Sahib's *dargah* and the privilege is shared by famous historians, physicians and other notables of Delhi. Strangely enough

Zabita Khan, the Rohilla Chief of Shaharanpur, and if local tradition is believed, his infamous son, Ghulam Qadir, from whom the proud house of Timur suffered the greatest wrong, also lie in close neighbourhood of their royal victims in the same compound Sultana Raziya (1236-1239), the only lady who occupied the throne of Delhi, however, found no place either near her father in the Quwwat-ul-Islam compound or in the shrine of Qutb Sahib Her unassuming tomb is to be found in an obscure lane near Turkman gate.

The Khalji-Delhi—Siri

Old Delhi lost some of its importance with the death of Balban in 1287. His worthless grandson transferred his head-quarters to Kilokheri, near modern Okhla, which became the new city for the time being Kaiqubad either built a new palace there or renovated an old castle that was in existence before his grandfather's reign. It was from here that he was kicked into the river and ~~out of existence~~ by the partisans of Jalal-uddin Khalji (1290-1295) who continued to live at Kilokheri, though the honour of the ceremonial capital still belonged to Quila Rai Pithora. No vestige of the Kilokheri palace has been preserved Alauddin Khalji (1296-1316) built a new capital for himself at Siri. His palace of thousand pillars, which witnessed so many pageants and tragedies, has completely gone to ruins. The Mughal menace had assumed serious proportions when this palace was built and beneath the foundation were buried thousands of Mughal heads It was here that Allauddin's general Malik Kafur displayed the rich booty that he brought from the south and it was here again that the great general met his end On the terrace of this palace was Allauddin's son Mubarak Shah (1315-1319) unceremoniously done to death by his lowborn favourite and for a brief spell the throne of the Khaljis passed to a Hindu outcaste who assumed the title of Nasiruddin Happily the palace of thousand pillars was not the only work on which Allauddin's fame as a builder rests Reference has already been made to the superb domed gateway of the Quwwat-ul-Islam that bears his name He had started building another minar opposite Qutb's that would outdo its predecessor in height and grace, but he did not live to finish the column and it stands to-day a living testimony to the futility of mortal efforts. At the western extremity of the new town Allauddin built a magnificent tank over an area of 70 acres It was extensively repaired by Sultan Firuz. Timur (1398) encamped on the bank of Allauddin's tank after his victory over the Delhi troops. The reservoir had at the time enough water to meet the needs of the people of the city. It presents to-day a sorry sight The tank has entirely gone dry though the stone steps built by Firuz Shah are still intact. The piety of that monarch built a madrasa here which is now in disuse. The good King was buried near this College and his tomb is in a fair state of preservation

Tughlakabad

Ghyasuddin Tughluq (1320-1325) went south in search of a suitable site for his capital. Of the fortress city of Tughlakabad, nothing remains but the bastioned walls and some underground chambers The lofty gateways and the triple storeyed towers still look impressive and the only monument from which some idea of the new architectural style can be formed is the Mausoleum of the Sultan built on an island-like mound and connected with the fort by a long causeway Ghyasuddin's tomb is worthy of a hardy soldier Extremely severe in outline and sparing in decoration it offers a remarkable contrast to the profusely ornamented gateway of Allauddin and the tomb of Iltutmish The sloping walls offer a sense of strength and support to a marble dome massive yet well proportioned Does the tomb reflect the reaction against the profligacy and pomp of the preceding period? According to the prevailing tradition, Ghyasuddin shares the tomb with his wife and eccentric son, Muhammad (1325-1351). How far this tradition is true we do not know Muhammad died in far off Sindh and the army was in a state of rebellion It is more likely that a younger son who shared his father's doom was also interred with him

Muhammad transferred his capital to Adilabad on the hills opposite The ramparts were of the same style as those of his father's city But Adilabad was abandoned for old Delhi again. Siri and the older city was enclosed within a protecting wall and Muhammad built another palace of thousand pillars in the enlarged capital which he styled as Jahanpannah or asylum of the world. The tower of Bijai Mandal and the Satpalah bund are the most notable remains of Jahanpannah. Muhammad's palace of thousand pillars was still extant at the time of Timur's invasion and its fame aroused the curiosity of some ladies of his seraglio. The archaeological Survey of India is now busy restoring what remains of the twin cities of Tughlakabad and Adilabad.

Firuzabad

Muhammad's cousin and successor Firuz (1351-1388) was a milder man but he could not rise above the all too common temptation of founding a fresh city Somewhat of an archaeologist, he repaired and

renovated some of the older monuments of Delhi but the urgent need of building materials led him to deeds of vandalism which to his own cost were readily emulated by others. As Hindu and Jain temples yielded materials for Qutb-uddin's mosque so the ruins of Siri and Jahanpannah were despoiled to find stones and bricks for Firuz Shah's capital. The pack animals of the local traders were requisitioned for a day and bricks were brought from the old city to the banks of the rivers. Firuzabad was a fairly big town and stretched from the river to Alauddin's tank and from the Kushak-i-Shikar on the ridge to the traditional site of the Pandava city. It included a large part of the later town of Shahjahanabad. Within the battlemented enclosure of the fortress Firuz built many palaces and public buildings Not a trace however remains of his palace of grapes, the palace of the wooden gallery and the palace of the public court which, in all likelihood, corresponded with the hall of public audience of the Mughal days. The ruins of the cathedral mosque that extorted unstinted admiration from Timur can be seen opposite the pyramid that bears the Asokan pillar. Alas it cannot be described even as a shadow of its departed grandeur Every old castle has its traditional secret passages and Firuz's Kotla is credited with no less than three, wide enough to allow his ladies to ride in palanquins One led straight to the river, the second connected the palace with the hunting box on the ridge and the third and the longest went towards Quilah Rai Pithora A deep hollow on the ridge is popularly believed to be the exit of the second of these tunnels but its mysteries are yet unexplored.

Firuz's minister the second Khan Jahan was also a great builder He has three notable mosques to his credit The Kalan Masjid near Turkman gate, the Khirki Masjid and the Begampuri mosque illustrate well the architectural style of the later Tughluqs The sloping pillasters lend the buildings an Egyptian air and the arches are without any key-stone The Mausoleum which the minister built for his father (the first Khan-i-Jahan) to the south of Sheikh Nizam-uddin Aulia's shrine supplied the model for the Sayyid and Lodi tombs.

From Firuz Kotla we may turn due south to Ghiyaspur where the *Dargah* of Hajrat Nizam-uddin still attracts thousands of devotees every year He commands the veneration of Hindus and Muslims alike We have already referred to Qutb Shah and Sheikh Mainuddin Chisti Nizam-uddin was third in apostlic order from Mainuddin and the second Chisti saint to lend sanctity to a suburb of Delhi. He came from the city of Badaun as a humble student to Delhi and refused to be tempted by the wealth and honour that the Sultanate, then at the height of its power, had to offer His immediate apostlic predecessor was Sheikh Farid-uddin whose association converted Ajodhan into Pak Patan Farid-uddin is said to have wrought many miracles and the admirers of Nizam-uddin credited him also with similar power The shrine contains a cistern, the saint's tomb and the superb mosque, attributed to Khizr Khan, eldest son of Allauddin Khalji Of the distinguished personages who sought their last resting place in this shrine, are Amir Khusru, the parrot of Hind who wrote verses in Hindi, Persian and Arabic, the gentle princess Jehanera, daughter of emperor Shah Jehan who shared the misfortunes of her father and the Emperor Muhammad Shah (1719-1748) who probably expected to be forgiven for all his lapses in this world through the intercession of the saint in the next Near the shrine of Nizam-uddin stand two mausoleums of a later day Shams-uddin Muhammad Atga Khan, Akbar's foster father was done to death by Adham Khan, a spoilt son of the emperor's foster mother Akbar, then in the prime of youth, stunned the murderer with a single blow of his fist and hurled him down a precipice. Adham Khan was interred on the outskirts of Rai Pithora's city and his tomb is still to be seen there His victim was buried in a pretty tomb specially built for the purpose by his son Mirza Aziz Kukaltash who himself sleeps in the Chausat Khambah near by

The Sayyids (1414-1450) who followed the Tughlaks were shadow Kings The first of the line preferred to rule as an agent of Timur rather than in his own rights but even he indulged in the vain luxury of a new capital Khizrabad has gone the way of Kilokheri and not a brick of Khizr Khan's palace is to be found His son gave his name to Mubarikabad, another city of fleeting fortune where the founder was entombed The third King of this dynasty was buried in the village of Khairpur

Of Lodi monuments (1450-1526) only two deserve special mention Bahlol (1450-1489) the founder of the family, probably ruled at Siri His son Sikandar (1489-1517) transferred his capital to Agra and Delhi suffered a temporary eclipse But the honour of receiving the mighty Sultan after his death was not denied to the traditional seat of Muslim power. The tomb of Sikandar Lodi looks like a fortress, a worthy resting place for so brave a warrior The battlemented enclosure gives the place a martial air which was quite in keeping with the departed monarch's taste. By a clever device the outer pillars are given a sloping effect so characteristic of this period and copious use is made of enamelled tiles of many hues both for inner and outer decoration. Sikandar's minister built the beautiful Moth ki Masjid and thereby hangs a tale

Purana Quilah

Babur (1526-1530), the founder of the dynasty of Great Mughals died in India but his mortal remains

were carried to Kabul. His son Humayun (1530-1540; 1545-1556) was chased out of the country by his Pathan rival Sher Shah Under Sher (1540-1545) and Humayun after him, Indraprastha once more came to its own. The Purana Qila where they held their court is within the bounds of New Delhi of to-day and marks the other end of the King's Way as we look down from the secretariat. As Firuz despoiled the older cities of Siri and Jahanpannah, Sher obtained his building materials from the ruins of Firuzabad One emperor pulled down the city of another without any compunction and many ancient monuments were thus lost to posterity Popular opinion attributes the enclosing walls of the fort to Humayun and the buildings inside to his rival If so, Akbar must have inherited his predilection for indigenous art from his father, for in the gateways of the old fort we find a happy synthesis of Hindu and Muslim styles The pointed arch happily combines with Rajput Chhatris Hindu pavilions are supported by Hindu brackets and the northern gate better known as Tallaqui Darwaja has among its decorations a rude representation of the solar orb and two panels depicting a man engaged in a mortal combat with a lion in half relief Over the northern gate we find similar panels with elephants instead The palaces inside the fort are gone and it is not possible to reconstruct the old plan until archaeology comes to the aid of history Only two notable buildings have been preserved, the Quila Kona Masjid which may rightly be regarded as the forerunner of a new style and Sher Mandal on the steep stairs of which Humayun missed his step and tumbled out of the world Visitors may be interested in a well in the compound of the mosque which testifies to the munificence of Amir Habibullah of Afghanistan (died 1919) Opposite the main or western gate of the fort and not far from it is Khair-ul-Manzil It is a combined mosque and college built by Akbar's foster mother Maham Anaga Like the Quila Kona Masjid it has a single dome. There is reason to believe that the Khair-ul-Manzil was meant exclusively for women and girls were admitted to the attached school

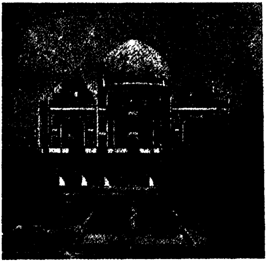
The Early Mughal Delhi—Din Panha

Humayun's Delhi or Din Panha probably extended as far south as his own cemetery which furnishes a fairly good example of Mughal garden tomb The Mughals delighted in terraced gardens with plenty of running water and fountains playing at intervals. They would provide for a cascade or a wide sheet or *chadar* of water if circumstances so permitted. The ground surrounding Humayun's tomb still retains the narrow courses through which water ran and several terraces can still be traced. Unfortunately most of the Mughal gardens have suffered from neglect and interference from people with a different taste The Shalimar has gone wild but some idea of what a Mughal garden was like can be formed from what remains of Raushenara garden near Sabji Mandi, the Talkatora garden at the foot of the ridge behind the Viceregal estates and the Qusiya garden outside the Kashmir gate The Mughal garden in the Viceroy's palace however offers a better illustration than any of its prototypes. Besides the garden with its fountains and running streams the tomb had for its complement a Madrasa and a mosque. The upper storeys of Humayun's tomb were designed to serve as a Madrasa Ghaziuddin's tomb near the Ajmer gate still houses an educational institution, the Anglo-Arabic College Although none of the most illustrious emperors of the house of Timur was interred here Humayun's mausoleum may be regarded as the imperial cemetery par excellence and more than one hundred members of the imperial family were buried in its vaults It was in Humayun's tomb that the last titular emperor Bahadur Shah had sought refuge after the mad orgies of the mutiny were over Verily this mausoleum is a mute witness of the rise, decline and fall of the Timurid power in India

Humayun's Mausoleum—A New Synthesis

Humayun's mausoleum marks the beginning of a new era in the history of Indian architecture It was built by his widow Haji Begam who had shared his exile in Persia The architect drew his inspiration from that country but had to adjust his design to the materials locally available and allowance had to be made for the taste and habits of his workmen The materials were not new Ghyasuddin Tughluq's tomb is built of marble and redstone, his nephew Firuz had used marble and sandstone in rebuilding the fourth and fifth storeys of Qutb Minar, the same combination was successfully utilized in Sher Shah's Quila Kona mosque White marble and sandstone were used with marvellous effect in the new mausoleum It is situated in a pleasant enclosed park of a fair dimension The enclosure is pierced by four lofty gateways wide enough to admit a full view of the building inside from a distance. The main entrance is approached by another gateway and the space between is planted with green shady trees. The mausoleum has a simple dignity all its own. As a work of architecture it can rightly claim a superiority over the more famous Taj The architect has successfully avoided the conventional severity of the later Pathans and the over ornamentation of the voluptuous Khaljis while courageously refusing to yield to the romantic sensuousness which mark

Mughal works of a later age The marble dome combines strength and solemnity and compares favourably with the bulbous superstructure below which rests Shah Jahan's queen Nor is it defaced by harsh black ribs which disfigure the dome of the Jami Masjid Indian workmen have left their indubitable mark on Humayun's tomb, though it is not perceptible



MAUSOLEUM OF HUMAYUN, DELHI

from below Around the dome they built four small rooms, airy and well-lighted with pillars and corbelled arches so characteristic of the country From the roof of Humayun's tomb can be obtained a panoramic view of Delhi, old and new, on a clear sunlit winter morning when the sky is blue and the atmosphere is dust free On one side the lofty minar towers above the green outlines of the hamlets below, the cyclopean rampart of the forsaken city of Tughluq Shah frown gloomy and forbidding and the marble dome of Ghyasuddin's tomb shines bright and dazzling, on the other side spread the two cities of Delhi and the war memorial and the Viceregal lodge can be clearly seen with the old fort, Firuz's Kotla and the tapering minarets of the Jami Masjid beckoning the weary wayfarer

From the terrace of the mausoleum is seen, outside the enclosure, the blue dome of another tomb, the barber's as it is commonly believed Most probably Fahim Khan, the faithful friend of Khan-i-Khanan Abdur Rahim Khan, lies buried here The dome must have once looked very lovely in its beautiful encasing of blue enamelled tiles. Abdur Rahim's own tomb, not far off, has unfortunately been shorn of all its ornaments. Irreverent hands removed all the marbles and only the naked core of the building remains. Yet Abdur Rahim deserved better of his country and country men. Son of Bairam Khan and a trusted minister of Akbar, he represented all that was best in Muslim and Hindu cultures. A good general and able administrator he devoted his scanty leisure to the cultivation of arts and his Hindi devotional verses have been universally admired No Hindi anthology will be complete without some hymn from Rahim's *Satsai* He knew how to reconcile the catholicity of the country of his birth, with the rigid demands of the faith to which he was born. The last notable garden mausoleum of Delhi is that of Safdar Jang, the second independent Nawab of Oudh but even a casual visitor will perceive that the style is conventional and decadent.

Outside the main enclosure of Humayun's mausoleum once stood a spacious hotel called Arab Serai It is now in complete ruins but Isa Khan's tomb, which stands next, has happily escaped this fate It is a typical Pathan mausoleum of the later days where the pseudo sloping pillars at the angles of the octagonal plinth conform to the common style. Yellow, green and blue enamelled tiles were used with good effect in the mosque confronting the tomb

SHAH JAHAN'S DELHI—SHAHJAHANABAD

Akbar (1556-1605) left Delhi for Sikri and Agra His son (1605-1627) passed through the old capital on his way to Kashmir It was left for Shah Jahan (1627-1658) to restore to the old capital its lost prestige and past pre-eminence Din Panha was associated with Humayun's misfortunes and Shah Jahan decided to build a new city and fortress palace that would excel those of Agra in grace and elegance While his grandfather built in red sandstone Shah Jahan built in costly marble, but at Delhi the red stone was once again permitted to play its part The lofty ramparts, the tall gateways, the music hall (Nakar Khana) and the spacious hall of public audience are in red stone. The principal palaces and the exquisite pearl mosque were built of nobler materials Shah Jahan himself planned the fort and divided the space into regular squares and rectangles. Inside the fort were office buildings, cantonment markets and residences of the palace officials besides the palaces where the Emperor and his family lived But a palace could not be considered complete without its complement of gardens, fountains and water courses Two lovely gardens, the Mahtab (moon) and the Hyat Baksh (life giving) embellished the open space and streams of water flowed not only through the gardens but through the very halls of the palace. A constant supply of water was for this purpose obtained from the Jumna by the ingenuity of Ali Mardan Khan, perhaps the greatest irrigation engineer of his time His stream of paradise (Nahr-i-Bihist) came over a scalloped marble cascade in the open arcade by the Shah Burj and fed

the tanks and fountains and rippled over the marble flowers and foliages in their shallow bed in the Rang Mahal creating an illusion to which none but a poet can do justice To revive the glory that Lal Quila once was, the visitor will have to call his imagination to service Man and time have caused havoc here. One of the gardens is completely gone, the female quarters have been entirely demolished and ugly barracks have raised their monstrous heads Modern utilitarian buildings offer but an incongruous setting for the poetry that Shah Jahan wrought in stone Yet some idea can be formed of his work from what remains of it. The Lahore gate almost faces the cathedral mosque opposite and leads through a vaulted passage flanked with shops and stalls to the Nakar Khana where music used to be played in the palmiest days of Mughal glory Beyond the Nakar Khana is an open space where the nobles used to crowd under a rich canopy on their way to the pillared hall of public audience Gone are the carpets, the awnings, the gold and silver railings that added to the grace of this far famed hall But the richly carved and inlaid marble platform where the Emperor sat high above his subjects is still there Here one can see some specimens of Italian pietra dura work and a small piece depicting Orpheus fiddling to wild animals is attributed to Austin de Bordeaux The hall of private audience with its well-known legend in Persian is still extant and so are the hamam, the Tasbih Khana, Rang Mahal, Khwabgah and the Pearl Mosque which served as the Emperor's personal chapel and two small pavilions named after two months of the rainy season Sawan and Bhadon below which running water with artificial illumination caused an illusion of the monsoon Three of the principal Burjs and all the gateways have been preserved but everything else is gone The Persian, the Afghan, the Maratha and the Jat all in the dire days of the Mughal downfall despoiled the palaces of their gold and silver ceilings and the precious stones with which the marble pillars were exquisitely inlaid After their cupidity was satiated came others who removed marble baths and other objects of art across the sea In the days of Akbar II the stately Dewan-i-Am became a common lumber room.

The Jami Masjid need not keep us long Its open courtyard can accommodate twenty thousand worshippers at a time and its twin minarets lend grace and lightness which the ribbed dome might minimize

The Chandni Chawk is not to-day what it was in the early days of Shahjahanabad A wide avenue ran from the Lahore gate of the fort to where the Fatehpuri Begam's mosque now stands and along it used to flow a pleasing *nahr* (water-course) The trees and running water gave the market place of the imperial city a rare attraction. We can imagine noble warriors riding along the avenue and the feudatory chiefs passing by on gigantic elephants, while veiled ladies in covered palanquins, with richly liveried attendants running by, added mystery to the busy market place Chandni Chawk has also its own history and shared the misfortune of the palace fort It witnessed the ghastly procession in which the unfortunate Prince Dara's head was carried It was from the terrace of the Sonheri Mosque, opposite the fountain, that the infuriated Persian invador Nadir Shah (1737) ordered a general massacre of the Delhi citizens and blood flowed like water through the wide thoroughfares of Chandni Chawk and Dariba. At a later date a remarkable lady whom history knows as Samaru's Begam lived in one of the buildings of this quarter

The brick wall that Shah Jahan built round his city is no longer in existence The present bastioned wall was built by Sir David Ochterlony in 1803. Originally the enclosing wall had fourteen gates and

COUNCIL CHAMBER, NEW DELHI

fourteen wickets Now only seven gates are known, though some of them have been demolished.

The most important late Rajput relic is outside the city walls Almost opposite the New Delhi Municipal Hall are some stout masonry works popularly known as Jantar Mantar This is one of the Observatories that Jai Singh II, the astronomer King of Jaipur (1699-1743), built under orders of Emperor Muhammad Shah at Benares, Ajmer, Jaipur and Delhi He was quite familiar with the work of western scientists and had some of the Latin text-books on the subject translated into Persian and got the Arabic version of Ptolemy's translated into Sanskrit under the name Siddhanta Samrat The observatories were built on the plan of Ulugh Beg's Observatory at Samarkand The Marathas once held Delhi under their sway but only two buildings bear testimony to their connection with the city The present Nili Chhatri temple near Nigambodh Ghat is a Maratha work and the Hindu Rao hospital bears the name of a Maratha noble

During the Mutiny Delhi suddenly sprang into a transitory importance The city walls near the Kashmir gate still bears the scars of those dismal days and not far from the wall are interred the mortal remains of Nicholson, one of the Mutiny generals

No account of Delhi will be complete without a reference to another early nineteenth century hero, Col Skinner, who gave his name to an intrepid body of irregular horse. Field Marshall Birdwood calls Skinner an Englishman, but Emily Eden found him too swarthy of complexion Skinner was a Eurasian in the true sense of the term His father came from the British isles and the mother belonged to the Bazar of Calcutta, and the son in his turn took a Muslim spouse He began his career in Sindhia's army and unlike many of his Christian colleagues refused to fight against his former master, though he resigned his commission when the second Maratha War broke out Skinner however rendered distinguished services to the new paramount power and his merit did not pass unrecognized In the days of his prosperity he paid an equal homage to the religions of his father, mother and wife by building a church, a temple and a mosque The Hindu College is at present housed in Skinner's Delhi residence and he lies buried with his friend Theophilus Metcalfe in the church he built (St James's Church).

From the early Muslim days there have been two Delhis, new and old Kilokheri, Siri, Tughlakabad, Firuzabad and Din Panha each in its turn claimed and lost the distinction of the new town Shah Jahan's city has to-day attained the dignity of Purana Shahar, while over the ruins of the old town of his time has been built the present capital of the Indian Empire (Raisina) The new city was to be built in conformity with the past practice north of the old city, but Nature intervened and *anopheles* disposed of what man proposed. Another site was found for the new metropolis but the old Viceregal Lodge was not doomed to share the evil fate of the palaces of thousand pillars When the capital moved south a new seat of learning, the University of Delhi, started its career in the former Viceregal Lodge

The following is a brief account of the centres of Educational and Scientific Institutions at Delhi

Delhi University

The Delhi University owes its existence to the Report submitted by a Commission of educational experts presided over by Sir Michael Sadler The University was established by an Act of the Central Legislature in 1922 (Act No VIII of 1922) (An amendment to the Act was necessary in 1943, due to the institution of Three-year degree course) It was brought into force from the 1st May 1922 and Dr Sir Hari Singh Gour, Kt , M A , D Litt , D C L , LL D , Barrister-at-law of Nagpur was appointed as the first Vice-Chancellor An important event in the development of the University was the transference by the Government of India in 1922, on a permanent lease, the Old Viceregal Lodge estates to provide accomodation (in the main building) for the University offices and suitable sites for the colleges

The University during the last six years has made progress in many directions, under the leadership of the present Vice-Chancellor, Sir Maurice Gwyer The most important of these are the institution of a three-year Degree course, re-organization of the secondary education, abolition of the two-year Intermediate course (one year of the intermediate course is added to the Degree course and one year to the school course), and the building up of well-equipped Science Laboratories

Early in 1942, the University Laboratories for Physics and Chemistry were completed and a laboratory for Biological Sciences is likely to function from the beginning of the academic session 1947-48 The teaching staff has been considerably increased and Three-year Honours courses and M Sc classes have been started.

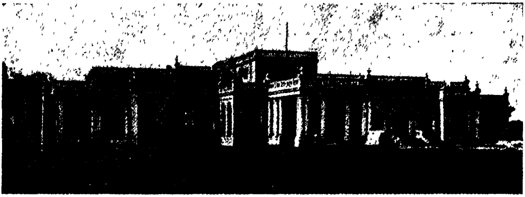
A number of colleges in Delhi are affiliated to the University and takes part in both, honours and post-graduate work Of these, St Stephens College, is the oldest and the largest and is in existence for over 60 years The present buildings are situated adjacent to the University

Ramjas College founded in 1917, became one of the three constituent colleges of the university in 1922. The college has been teaching upto M.A

standard in almost all subjects and upto the Intermediate standard on the science side A new site for the college has been allotted in the University area.

Hindu College founded in 1899, provides teaching upto the M A. standard in Arts and only preliminary and Pre-Medical instruction in Science It is also to be located in the University area.

part of the university laboratories. In April 1942, the Government of India constituted the Council of Scientific and Industrial Research on a Permanent footing The object of this organization is to secure (1) that donations made by industrialists are entirely devoted to initiate and promote industrial research and (2) a simple procedure that will ensure the work of the organization being carried on as expeditiously



THE UNIVERSITY (Old Viceregal Lodge)

The Anglo-Arabic College is of recent growth, although its history can be traced back to 1792 The college now provides M.A classes in Persian, Arabic, English, History, Economics and Philosophy

Commercial College established in 1920, provides training in Commerce upto Honours standard and students are also enrolled for M A in Economics

Council of Scientific and Industrial Research

The Board of Scientific and Industrial Research (B S I R) was set up on the 1st April 1940 for a period of two years in the first instance and its functions were to advise the government on the lines on which scientific and industrial research should be conducted in order to develop Indian industries whose importance have been brought out into the forefront owing to the conditions created by World War II Laboratory facilities were first provided for at the Alipore Test House, Calcutta Financial assistance was given for remunerating research workers and laboratory equipment and the co-operation of research institutes and of universities was secured.

Early in 1942, when the laboratories for Physics and Chemistry of the Delhi University were nearing completion, the Board of Scientific and Industrial Research shifted from Calcutta to Delhi and by arrangement with the university, occupied the major

as possible The Council is a Registered Society under the Registration of Societies Act (Act XXI of 1860) and the actual administration of the affairs as well as the funds are entrusted to a Governing Body A fund called *Industrial Research Fund* was constituted by grants from the central revenues, provincial governments, industrialists, universities etc The Government of India provides an annual grant of Rs 10 lakhs to the Fund Mr C Rajagopalachari, Member for Industries and Supplies, is now the president of the Governing Body of the Council The Council has two standing advisory bodies *viz*, the Board of Scientific and Industrial Research and the Industrial Research Utilization Committee.

Comprised in the organization of the council are two self-contained units *viz*, (1) a monthly journal entitled "Journal of Scientific and Industrial Research" and (2) compilation of a "Dictionary of the Economic Products and Industrial Resources of India" The latter work has been undertaken with a view to bring the information contained in "The Commercial Products of India" by late Sir George Watt (1908), up-to-date

National Laboratories

Plans have been completed for the establishment of five National Laboratories under the auspices of the

C S.I.R. of which "The Central Glass and Ceramic Research Institute" was inaugurated by Sir Ardeshir Dalal in December, 1945 at Jadavpur (Bengal) and a sum of Rs. 10 lakhs is provided towards the capital expenditure of the Institute

"The Fuel Research Institute" was inaugurated by Mr C H. Bhabha at Digwadih (Dhanbad) in November last, at an estimated capital cost of Rs 14 lakhs The "National Metallurgical Laboratory" was also inaugurated in November last by Mr C. Rajagopalachari at Jamshedpur at an estimated capital expenditure of Rs 42 lakhs

The National Chemical Laboratory is to be established at Poona at an estimated capital cost of Rs 33 lakhs.

The National Physical Laboratory is to be established at Delhi at an estimated capital cost Rs 40 lakhs The foundation stone of this Laboratory, will be laid by Pandit Jawaharlal Nehru during the Science Congress week at a site close to the Imperial Agricultural Research Institute at New Delhi Considered from various points *viz* , proximity to several academic centres (and industrial towns), like the Meteorological department, the Agricultural department, the Medical department, the Royal Air Force, the All-India Radio, the Railway Board etc , Delhi has been selected as the place for the location of this laboratory Research work undertaken by this laboratory will include :—

(1) Research on Standards
(2) Research in Applied Physics
(3) Fundamental Scientific Research

A Road Research Station is also to be established at Delhi.

INDIA METEOROLOGICAL DEPARTMENT

The department was instituted in 1875 to coordinate, combine and extend the work of various provincial organizations established between 1865 and 1871. The duties of this department at the time included "the study of the weather and climate of India as a whole and the application of the knowledge thus acquired to the issue of storm and other warnings and of day to day weather reports and forecasts".

The department has since then considerably expanded its activities. It has a central All-India Weather office at Poona, an Upper Air office at New Delhi, Forecasting offices at Calcutta, Karachi, New Delhi, Peshawar and Lahore, and Observatories at Bombay and Kodaikanal The office of the Director-General is now stationed at the Aerological Observatory on Lodi Road.

There is also an "Agricultural Meteorology Branch" at Poona to study weather as affecting plant life and a "Geophysics and Solar Physics Branch" at the Colaba and Alibag (Bombay) observatories Seismograph are maintained at Bombay, Calcutta, New Delhi, and Kodaikanal The work at Colaba and Alibag observatories are placed in an internationally agreed programme

MALARIA INSTITUTE OF INDIA

The Institute is in existence since 1927, when it was known as 'Malaria Survey of India' The title was changed in 1938 The headquarters of the Institute was originally at Kasauli and is now located at Delhi The Public Health section activities of the Institute has now been taken over by the Government of India, while its research activities continue to be provided for from the Indian Research Fund Association funds

The functions of the Institute are concerned upon all problems and investigations on malaria , to carry out systematic research work on malaria transmission, and epidemiological investigations , to advise on anti-malaria measures and to undertake clinical work on malaria.

The institute acts as a bureau on all matters connected with malaria in any part of India and publishes from time to time malaria *Bulletins* and a *Journal*, and also *Memoirs* on special topics.

NATIONAL INSTITUTE OF SCIENCES OF INDIA

The National Institute of Sciences of India was formally founded on the 7th January, 1935, at a meeting held in Calcutta. This is a senior body of scientists having a status and functions similar to those enjoyed by the Royal Society, to promote the cause of science in India The headquarters of the Institute has been still recently in Calcutta. With the recognition of the institute as the premier scientific body in India, by the Government of India, the headquarters is being gradually shifted to Delhi, at the University.

The Institute besides holding meetings for reading of original papers, also holds special meetings on selected topics. These are published in monthly *Proceedings* and *Transactions* Besides the Institute has undertaken publication of *Indian Science Abstracts* which consists of a bibliography of science in India.

The Institute receives grants from the Government of India, the Rockefeller Foundation, and also the Imperial Chemical Industries.

The membership of the Institute is little over 200

THE IMPERIAL ARICULTURAL RESEARCH INSTITUTE.

The institute was originally established at Pusa (Bihar) in 1905 with the help of a princely donation

of £30,000 made by Mr Henry Phipps, an American Philanthropist. The earthquake of January, 1934 having caused irreparable damage to the Institute, the Government of India decided to rebuild it at a more central place. The new Institute built in New Delhi in 1936 covers an area of nearly 837 acres of which 360 acres are occupied by buildings, roads and pastures and the rest is good cultivable land

The central building of the Institute, with a clock tower, is the Library, containing nearly 80,000 volumes and is considered to be the biggest one of its kind in the East.

The work of the Institute at Delhi is shared by five main Sections—Agriculture, Botany, Agricultural Chemistry and Soil Science, Entomology, Mycology and Plant Pathology. The Imperial Sugarcane Breeding Station at Coimbatore is another Section of the Institute.

Each of the five Sections at Delhi is housed in a separate block of buildings. The Agricultural Section consists of a main building for the Office, a fully equipped Dairy cattle byre, a Veterinary dispensary, bull runs, etc. The main lines of research work carried on in this Section are the trials of various manures and crops, problems of irrigated and rotational cropping and testing of bullock and power-driven implements Problems of cattle breeding include the work on the pedigree Sahiwal herd, early maturity experiments, hormone therapy and artificial insemination The Section cultivates over 400 acres of land.

The Botanical Section has a block of rooms equipped for all modern lines of work on plant breeding, cyto-genetics and physiology There is an area of about 50 acres attached to this Section for conducting field-experiments The research work of the Section includes the production and maintenance of improved varieties of different crop plants and of the study of genetical, cytological and physiological problems.

The Section of Soils and Agricultural Chemistry consists of a big laboratory named after Henry Phipps with modern equipment for work in the investigation of soils and manures and has facilities for micro-analysis, soil physics, soil-microbiology, physical chemistry, plant chemistry and soil survey. Study of the scientific and economic questions involved in the utilization of agricultural produce and waste forms part of the investigations conducted by the Section.

In the Entomological Section there is a main block of rooms for laboratory work including the rearing of insects to study their habits and life-histories There is also a parasite-breeding laboratory consisting of chambers for controlling temperature and humidity and an insect-proof cage-house Among recent developments of the Section is the study of the biological control of insect pests.

The Mycological Section has a number of rooms for laboratory work, a separate room for inoculation and equipment for maintaining even temperatures Among the activities of the Section are the investigations of the smut diseases of cereals and measures for their control, the study of the soil-borne diseases of various crop plants including sugarcane virus diseases and problems connected with the wastage of potatoes and fruits It maintains a herbarium of specimens of diseased plants

On the educational side, the Institute offers post-graduate courses in modern methods of agricultural research, the basis of instruction being the research work in progress These courses are limited to a period of two years in the subjects of botany, chemistry, entomology, mycology and plant pathology and to one year in agriculture In addition to these, short courses of instruction are given in special subjects such as flue-curing of tobacco. Students receive the Associateship of the Institute on completion of the two-year course

SHORT LIFE SKETCHES
OF THE
General President and Sectional Presidents

General President

PANDIT JAWAHARLAL NEHRU, the Vice-President of the First Provisional National Government of India, will preside over the thirty-fourth session of the Indian Science Congress, which is meeting this year in Delhi from Jan 2 to Jan 8 At a time when India is at the threshold of her political independence and is about to undertake vast programmes of national reconstruction and development, it is of the greatest significance that a valiant fighter of freedom—one who is well-known for his deep conviction of the great role science is destined to play in national regeneration—should have presided over the deliberations of the country's scientists and technologists.

As essayist, historian, social thinker and, above all, a great political leader intimately associated with the freedom movement during the last quarter of a century, Jawaharlal Nehru represents the dynamic and progressive forces of Modern India. Early in life, at Harrow and Trinity, he came under the profound influence of Lowes Dickinson, and Bertrand Russell. The writings of Marx and Engels and developments in contemporary Soviet history appealed to him and influenced his writings and utterances It is natural that he has been described by many as a socialist leader, if not in politics, in his economic theories of collective enterprise at least, he has no doubt remained a socialist

"First in War, First in Peace, and First in the hearts of his countrymen"
(Tribute to Pt. Jawaharlal Nehru by Prof Meghnad Saha on the occasion of the 3rd Anniversary of National Academy of Sciences, India, at Allahabad).

His deep study of history and current international affairs has given him an advantage in Indian politics which he always tries to analyze and understand against the broad background of international developments Among Indian leaders he was early to realize that India's independence, apart from her own benefit, has a great international significance and is a vital factor in the promotion and maintenance of world peace It is his firm conviction that India, by virtue of her pivotal position in geography, is destined to play a leading part in renaissant Asia, and, that in not distant future, the centre of gravity of international politics will inevitably shift from Europe to Asia His move to convene and organize an Asiatic conference early this year, immediately on acceptance of office in the Interim Government, bears testimony to this conviction and far sight

To the scientists, his views on science and technology, on the desirability of their application in human affairs, and on the need of planned development are of more immediate

concern On these questions he has always been clear, unambiguous and emphatic He has been himself a great admirer of scientists and believes in the potential forces of science which has freed peoples, in those parts of the world where it has been cultivated and consciously applied, from medieval serfdom and poverty If we are to solve India's problems of chronic poverty, low standard of living, malnutrition, very heavy annual toll of lives due to preventible diseases and various other evils, we have to appeal to science and technology 'It was science alone', observed Pandit Nehru, in his message to the Silver Jubilee Session of the Science Congress in 1938, 'that could solve these problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabitated by starving people'

He further continued,

" If science is the dominating factor in modern life, then the social system and economic structure must fit in with science or it is doomed Only then can we plan effectively and extensively Lord Rutherford tells us of the need for co-operation between the scientist and the industrialist That need is obvious So also is the need for co-operation between the scientist and the politician.

I am entirely in favour of a State organization of research I would also like the State to send out promising Indian students in large numbers to foreign countries for scientific and technical training For we have to build India on a scientific foundation, to develop her industries, to change the feudal character of her inland system and bring her agriculture in line with modern methods, to develop the social services which she lacks so utterly to-day, and to do so many other things that shout out to be done For all this we require a trained personnel "

The social aspects of science have appealed to him more than anything else He deeply appreciates the usefulness of science as a mental discipline and only wishes that this discipline is extended in the sphere of social behaviour "The applications of science are inevitable and unavoidable for all countries and people today But something more than its application is necessary. It is the scientific approach, the adventurous and yet critical temper of science, the search for truth and new knowledge, the refusal to accept any thing without testing and trial, the capacity to change previous conclusions in the face of new evidence, the reliance on observed fact and not on preconceived theory—all this is necessary, not merely for the application of science but for life itself and the solution of many problems" With all his enthusiasm for science, he has, however, refused to accept it as an unmixed blessing and has placed greater emphasis on Man and his purpose. It is more essential to have knowledge of man's ultimate purposes, so miserably lacking at present. Without this knowledge which alone can give him control over himself, he runs the risk of being controlled by the blind forces of his own scientific inventions, which may often prove disastrous.

Although an ardent follower of Mahatma Gandhi in the struggle for political freedom, he has never wholly approved of Gandhian theory of economic development as based primarily on spinning wheel and cottage industries. To him industrialization of India is not only desirable but inevitable if a decent standard of living has to be eked out for the common man This industrialization must be brought about through the fullest possible development and utilization of the country's power resources, thermal as well as hydro-electric 'The three fundamental requirements of India', he has observed in his recent famous book *Discovery of India*, 'if she is to develop industrially and otherwise, are a heavy engineering and machine-making industry, scientific research instietutes, and electric power' Elsewhere he has dwelt on this subject at length and stated

" . It can hardly be challenged that, in the context of the modern world, no country can be politically and economically independent, even within the frame-work of international interdependence, unless it is highly industrialized and has developed its power resources to the utmost Nor can it achieve or maintain high standards of living and liquidate poverty without the aid of modern technology in almost every sphere of life An industrially backward country will continuously upset the world equilibrium and encourage the aggressive tendencies of more developed countries Even if it retains its political independence, this will be nominal only, and economic control will tend to pass to other This control will inevitably upset its own small-scale economy which it has sought to preserve in pursuit of its own view of life Thus an attempt to build up a country's economy largely on the basis of cottage and small-scale industries is doomed to failure. It will not solve the basic problems of the country or maintain freedom, nor will it fit in with the world frame-work, except as a colonial appendage "

But that does not imply that he is opposed to cottage industries having any place in India's economy. Far from it. When it is remembered that the country we at present live in is a country of villages with more than seventy per cent of the population living in them, the advantages of certain development of cottage and rural industries seem obvious enough In a way, such industries will themselves act as a great solvent of our staggering problem of unemployment and must play an important role during our transition from the rural to the industrial economy Moreover, although a strong advocate of large-scale industrialization, he is fully alive to the dangers of unplanned and unbriddled capitalism following in the wake of such industrialization. No doubt more wealth will be created in this way, but it will inevitably lead to more unemployment and greater concentration of wealth in the hands of the few making the poor the poorer, create fresh and more powerful vested interests, and bring about

further loss of freedom for the common people He is 'all for tractors and big machinery', but is 'equally convinced that the most careful planning and adjustment are necessary if we are to reap the full benefit of industrialization and avoid many of its dangers'

This at once explains his deep interest in planning When the National Planning Committee was established at the instance of Netaji Subhas Chandra Bose, then president of the Congress, he accepted the chairmanship of the Committee, as the work was after his heart and he could not keep out of it From the beginning he realized that planning, if it was to be successful, had to be comprehensive and cover almost the whole range of human activity Such a planning inevitably involves fundamental changes in the social and economic structure, which cannot be undertaken except under the auspices of a free national government. Despite these limitations he went ahead with the planning work, because 'the attempt to plan and to see the various national activities—economic, social, cultural—fitting into each other, had also a highly educative value for ourselves and the general public It made the people come out of their narrow grooves of thought and action, to think of problems in relation to one another, and develop to some extent at least a wider co-operative outlook '

In his planning work, the influence of socialism is ostensively visible. For obvious reasons, the Committee could not start with a well-defined social theory, but their social objectives were clear enough and afforded a common basis for planning Thus, defence and key industries and public utilities were to be State-owned The ownership of agricultural land, mines, quarries, rivers and forests must rest absolutely in the people of India collectively Even a socialized system of credit was envisaged and State regulation of capital and credit suggested There was of course allowance for free enterprise but its scope was severely restricted "Constituted as we were, not only in our Committee but in the larger field of India," he wrote, "we could not then plan for socialism as such Yet it became clear to me that our Plan, as it developed, was inevitably leading us towards establishing some of the fundamentals of the socialist structure "

Great as a political leader, Jawaharlal Nehru is no less eminent as an essayist, writer and social thinker. He has an astonishing narrative power which never loses its freshness and vivacity He has written volumes in spite of his multitudinous and ceaseless activities and fourteen years in British prison, which include *Recent Essays and Writings, Letters from a Father to His Daughter, Whither India? A Window in Prison and Prison Land, India and the World, Autobiography, The Unity of India, Glimpses of World History,* and *The Discovery of India* But all of his three famous books, *Autobiography, Glimpses of World History* and *The Discovery of India* were written during his enforced rest in different prisons in India, his 'leisure and detachment', as he calls it An English reviewer (S K Ratcliffe · *John O' London's Weekly,* September 20, 1946) has remarked

'Jawaharlal Nehru takes rank with the greatest of prisoner authors *The Discovery of India* is the third important work he has produced in jail, the notable *Autobiography* of twelve years ago having been followed by *Glimpses of World History*, in the form of letters to his daughter

He wields a pen astonishing in narrative power, and in our mother tongue It is used to be said during my time in the East that while the trained Indian's handling of English was always remarkable, and often in oratory dazzling, even the best examples were not wholly free from typical faults Tagore, perhaps, was the first undeniable master Gandhi's plain English is entirely right for his purpose Mr Nehru, one would dare to say, has very few superiors in this country or elsewhere if judged by lucidity and animation, by range of subject and expression He is abundant without wordiness, and the vivacity of his writing is never slackened '

The future of India rests secure in the hands of men like Jawaharlal Let us conclude with a line from a tribute Prof Meghnad Saha once paid to him · "He is First in War, First in Peace, and First in the Hearts of his countrymen "

S N Sen

R. C. BOSE

President, Section of Statistics

Born at Hoshangabad (C P) in 1902, Mr R C Bose received his education at the Government High School, Rohtak (Punjab), the Hindu College, Delhi, and the Post-graduate department of the Calcutta University He had a uniformly brilliant school and college career, culminating in a First Class first M A in Pure Mathematics of the Calcutta University in 1927 Immediately afterwards he joined the Calcutta University as a research scholar, under Dr Shyamadas Mukhopadhyaya, and began his work on Non-Euclidean Geometry, and the im-grössen problems of Differential geometry In 1930 he joined the Asutosh College, Calcutta as a lecturer in Mathematics, and continued his geometrical work. Meanwhile the pioneering labours of Professor P C Mahalanobis had culminated in the foundation of the Indian Statistical Institute with himself as the founder-director. Mr Bose was early attracted by the possibilities of the new science and joined the institute first as a

Sciences, and a Vice-President of the Geological, Mining, and Metallurgical Society of India

A keen sportsman, Dr Pichamuthu obtained his colours in Cricket while playing for the Glasgow University.

A. C. JOSHI

President, Section of Botany

Professor Amar Chand Joshi was born on 18th of September, 1908, at Bahadurpur, a suburb of Hoshiarpur, situated at the foot of the Siwalik Range in the Panjab. He joined the local D A V High School in 1916 and matriculated in 1924, obtaining a high First Class and also winning a University Scholarship He moved then to Lahore and studied at the Forman Christian College, the Government College

and the Panjab University Honours School in Botany He passed the B.Sc. (Honours School in Botany) and M.Sc. (in Botany), with a high First Class In the latter examination, (1930) he stood First not only among the Botany students, but topped the list of successful candidates in all science subjects of that year and was awarded the Maclagan Gold Medal of the University. In 1937, he was admitted to the D.Sc. degree of the Panjab University, being the first to receive it after the institution of a lower Ph D. degree.

After passing the M.Sc. Examination in 1930 Dr Joshi worked for sometime as a Demonstrator in Botany in the Panjab University and was soon after appointed an Assistant Professor of Botany at the Benares Hindu University. His merits were soon recognized and he was subsequently promoted to Professor of Botany. Dr Joshi stayed at Benares for nearly 13 years and did most of his work at this place, which brought him a high reputation among the Indian botanists.

He served for sometime (1944-45) as an Assistant Editor (Botany) for the Dictionary of Economic Products and Industrial Resources of India, now being compiled under the Council of Scientific and Industrial Research of India. In December 1945, Prof Joshi succeeded the late Prof. S L. Ghosh as Professor and Head of the Department of Botany, Government College, Lahore a chair once occupied by his teacher, the late Professor S R. Kashyap.

Dr Joshi is a keen and enthusiastic researcher and has published a very large number of papers dealing with the anatomy, morphology, embryology, cytology and systematics of the flowering plants, but his work has not been restricted to these subjects only He has a wide range of knowledge in different branches of Botany and is a man of wide culture and outlook

Based on anatomical and genetical studies, Prof Joshi is a supporter of the classical theory on floral morphology—according to which the gynaecium is composed of one or more, free or variously united carpels, and each carpel is morphologically equivalent to a leaf folded upwards along its midrib and bearing ovules along its incurved margins According to Prof Joshi evidences are not strong enough to support the modern cytonialean carpel of Hamshaw Thomas, the theory of carpel polymorphism of Saunders and the theory of Acarpy of Mclean Thomson

Prof Joshi revised and completed "Lahore District Flora", so enthusiastically commenced by his teacher late Prof Kashyap The book is published by the Panjab University (1936) Prof. Joshi has also guided with distinction many students who have also made important contributions to botanical science.

Prof. Joshi was elected a Fellow of the National Institute of Sciences of India in 1938, and has also been for three years a member of its Botany Sectional Committee He has been a member of the Executive Council of the Indian Botanical Society for nearly 10 years and was Vice-President for 1944. He is at present its Honorary Treasurer and Business Manager of the Journal He is a member of the Plant Breeding and Editorial Committees of the Indian Council of Agricultural Research. He was Recorder of the Botany Section of the Indian Science Congress held at Delhi in 1944, and served on the Council of the Association during 1944-45. He is also connected with several other scientific societies and has been taking keen interest in the development of science in India.

G. D. BHALERAO

President, Section of Zoology and Entomology

Dr G D. Bhalerao, Officer-in-charge of the Veterinary Zoology Section, Imperial Veterinary Research Institute, Izatnagar was born at Wardha on the 10th December 1897 He graduated in 1920

from the Hislop college and the College of Science, Nagpur. Later, he took his Ph.D. in the Faculty of Medicine and D.Sc. in the Faculty of Science of the University of London. He is also a D.Sc. in Zoology of the University of Allahabad. As a teacher of Zoology he has successively served as the Professor of Zoology in the Hislop college, Assistant Professor of Zoology in the College of Science, Nagpur, and as a lecturer in Biology in the University of Rangoon.

Dr Bhalerao made notable contributions to Parasitology, publishing in all about 90 papers in several foreign and Indian journals and the book entitled "Helminth Parasites of the Domesticated Animals in India." He has now been commissioned by the Secretary of State for India to write volumes on TREMATODA in the 'Fauna of British India'. His work in Parasitology is widely known and has been incorporated in the text-books published on the subject in all countries of the world during the past nearly twenty years. While in England he was placed on the panel of experts to identify helminths obtained from the animals dying in the London Zoological gardens. He was invited to contribute articles to the jubilee volumes published in Russia, Japan and America in honour of Professors Skrjabin, Yoshida and Travassos respectively and an article to the Encyclopaedia published in Holland. He is a member of the Editorial Board of the "Great English-Indian Dictionary",

In 1942 he acted as the President, Section of the Medical and Veterinary Sciences of the Indian Science Congress. He was the President of the Helminthological Committee of the Indian Council of Agricultural Research, New Delhi in 1942. He is the President of the Research Workers' Association of the Imperial Veterinary Research Institute, Izatnagar and Mukteswar-Kumaun.

(MRS) IRAWATI KARVE

President, Section of Anthropology and Archaeology

Born in Myingyan (Upper Burma) on the 15th December 1905, Dr Mrs Irawati Karve (*nee-karmakar*) was educated at the Poona High School for Indian girls, from where she matriculated in 1922. She took her B A. degree from the Fergusson College, Poona and later passed the M A. of the Bombay University, from the Bombay School of Sociology and Economics, by a thesis on Sociology

In 1926, she married Dr D. D. Karve, Professor of Chemistry, (now Principal), Fergusson College, Poona. In 1928, she joined the Berlin University, and studied Anthropology at the Kaiser Wilhelm Institute for Anthropologie under Prof. Eugen Fischer in Berlin, Dahlem, and obtained her doctorate (Ph D) in December 1930 During this period she

received for some time the Humboldt Scholarship and was also helped by the Sir Dorab Tata Trust and the Wadia Trust, Bombay.

From 1931 to 1937, she acted as the Registrar, Indian Women's University and since 1939, is serving as a Reader in Sociology, Deccan College Research Institute.

Dr Karve has published a large number of papers embodying her original investigations on the kinship systems in *Rigveda*, *Atharvaveda* and *Mahabharata*, on the kinship usage of the Gujarat, Kathiawad and Maratha countries She also reported the anthropometric measurements of the *Madhyandin Brahmins* of the Maratha country and on the skeletal remains of the prehistoric expedition in Gujarat

G. PANJA

President, Section of Medical and Veterinary Sciences

Professor Ganapati Panja was born of a poor Ugrakshatriya family in a village in the district of Burdwan, Bengal He lost his parents at the age of seven and had therefore to strive hard and fight against enormous odds for the prosecution of his early studies He was a scholar all throughout his career from the upper primary school examination to the final M B examination of the Calcutta University While a student in the Hindu School of Calcutta,

he wrote a booklet in Sanskrit language very much like "*Hitopadesham*". He was recipient of several gold medals in various subjects, F C Chatterjee's scholarship in Morbid Histology and also the best man's scholarship in the Medical College, Calcutta During his student life in the Medical College he wrote a book on Materia Medica which was widely appreciated He passed the M B examination in 1919, and served as a house staff in the various departments of the Medical College Hospital He joined the Calcutta School of Tropical Medicine as an Assistant Professor of Bacteriology in 1921 and came under the influence of Lt Col H W Acton, I.M S He used to take keen interest in Dermatology, Mycology and Bacteriology since his student days and it was the influence of teaching of Col. Acton that soon paved his career as a renowned dermatologist not only in Calcutta but all over India. He received the Rockefeller Foundation Fellowship in 1932 that enabled him to proceed abroad and he passed the D.Bact examination of the London University and also the certificate examination of the London School of Dermatology Prior to his return to India, he visited and followed the dermatological work done in the Edinburgh Royal Infirmary and various dermatological clinics on the Continent He officiated on several occasions as Professor of Bacteriology and Pathology in the School of Tropical Medicine and published a large number of original papers His successful cultivation of the *Malassezia* (of dandruff) and *pityriasis versicolor*, introduction of a new method for isolation of vibrios from cholera stool, new approach to the antigenic study of vibrios and successful elucidation of the aetiology of tropical phagedenic ulcer, are outstanding He is the first and only Indian till today, to introduce a highly successful culture medium (D F C medium of Panja and Ghosh) for cultivation of intestinal pathogens, such as dysentery, enteric and cholera microorganisms

Professor Panja is a hard-working man and takes immense interest in research He is a man of amiable disposition and is a great lover of arts and horticulture

N. L. DUTT

President, Section of Agricultural Sciences

Mr Nand Lall Dutt is an alumnus of the Panjab University having obtained the B.Sc (Hons.) and M Sc. in Botany under the guidance of the late Rai Bahadur Prof. S. R. Kashyap, D Sc., I.E S. In 1923 Mr Dutt was selected for training in Economic Botany and Plant Breeding at the Imperial Agricultural Research Institute, Pusa (now at New Delhi) and in 1926 was appointed to the post of Second Cane Breeding Officer under the then Sugarcane expert, Sir T. S Venkatraman, at the Imperial Sugarcane Breeding Station, Coimbatore As Second Officer Mr Dutt's duties were concerned mainly with

the breeding of economic seedling canes for the tropical parts of India, *viz.*, the Bombay and Madras presidencies. In collaboration with Sir Venkatraman he was successful in releasing, among others, the now famous *Co. 419* which has done so well in Bombay, Deccan and also in the cane tracts of Madras Mr Dutt has published a large number of scientific papers on the plant breeding, cytological, taxonomic and the plant physiological (regarding flowering of sugarcane) aspects of the work at Coimbatore.

On the retirement of Sir T S Venkatraman in 1942, Mr Dutt succeeded him as the Sugarcane Expert In 1944 Mr Dutt conducted a survey of sugarcane research in India on behalf of the Indian Council of Agricultural Research, New Delhi, and his findings and recommendations are contained in the 'Report on the Survey of Sugarcane Research in India (1946)'.

S. A. RAHMAN

President, Section of Physiology

Prof. S. A. Rahman took his medical degrees from the University of Edinburgh As an undergraduate, he obtained several merit certificates and also the first prize in Surgery. After his return to India he worked for some time in the Osmania General Hospital (Hyderabad) in an honorary capacity and was then appointed as Civil Surgeon in the Hyderabad State. He went back to Edinburgh and worked with Prof. Sir E. Sharpey-Schafer in the Department of Physiology In 1930 he was appointed Professor of Physiology at the Osmania Medical College, Hyderabad He has many research papers to his credit. In 1938 he was invited, along with

many of the prominent physiologists of the world, to contribute to the "Book of Homage" which was published in Brazil in 1939. About 3 years ago he was deputed by the Government of Hyderabad to proceed with an instrument called the "Pulfrich Photometer" to Dr Gajjar's Laboratories at Bombay in order to be of help in the investigation of blood chemistry in connection with Mahatma Gandhi's illness.

P. S. NAIDU

President, Section of Psychology

Mr Naidu has been an University teacher for the last thirty years He commenced his career at Madras, and later at Annamalai and is now at Allahabad in charge of Psychology and Experimental Psychology Departments. At Annamalai, he was the founder of the Psychological Laboratory.

In 1941, Mr Naidu presided over the Psychology section of the Indian Philosophical Congress and was the Miller Endowment Lecturer of Madras University for the year 1945-46

He is actively connected with the Inter-Universities and Educational Conferences and is now head of the Education Section at Allahabad, in charge of candidates engaged in working out a five-year plan

of constructing and standardizing all types of psychological tests.

Mr Naidu has about 100 original papers, published in various learned journals to his credit and is the author of books entitled "Utilization of India's Manpower" (Bombay 1945) and "The Hormic Theory" (Allahabad, 1946).

H. P. BHAUMIK

President, Section of Engineering and Metallurgy

Having passed out from the Thomason Civil Engineering College, Roorkee in the year 1905, Mr Bhaumik was appointed to the Engineering Branch of the Government Telegraph Department as Assistant Superintendent. He served in several provinces of India and also in Burma as Assistant Divisional Engineer and Divisional Engineer and was appointed special officer on several occasions for investigating Engineering Techniques with a view to improving the working of the Department. In the office of the Electrical Engineer-in-Chief he carried out major technical and experimental works and assisted in the manufacture of Technical Apparatus in the Government Telegraph Workshops, Calcutta,—apparatus, which were formerly being imported from outside India. The important work of training the staff in Electro-Technology was also entrusted to him at this time. In 1931, he became Electrical Engineer-in-Chief. During his time, Long Distance (Trunk) Telephone working was firmly established in India, and Multi channel Telegraph and Telephone Carrier working was brought into use, marking a definite advance in Electrical Communication in India. The India-England Radio Telephone Link was opened in 1933 under his supervision and guidance. In 1935 he was appointed Postmaster General, Madras Circle from which position he retired in 1937. He was made an O B.E in January, 1934.

After retirement, he has been closely connected with the activities of the Institution of Engineers (India) which is the only chartered body of Engineers in this country. He was President of the Institution for the year 1945.

He is also connected with the administration of the College of Engineering and Technology, Jadavpur, being a member of its Executive Committee and is Ordinary Fellow of the Senate of the Calcutta University.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. FEBRUARY, 1947 No. 8

INDUSTRIAL PLANNING FOR INDIA*

INDUSTRIAL planning in India should aim at a rapid transition from the present colonial economy of raw materials produced by exploited labour to a national economy of manufactured goods produced, in abundance, by skilled workers, enjoying the fruits of their labour We now export agricultural and animal produce like jute, cotton, tea, coffee, hides, oil seeds, and raw minerals like manganese ore, chromite, mica, ilmenite, petroleum, magnesite, kaynite etc Often the price of raw materials bears no relation to the price of the manufactured product, *e g*, taking an extreme case, the price of ilmenite, exported from Travancore, is 10*s* per ton, while the pigment titanium dioxide sells at £100 per ton

In exchange for our raw materials, we import (1) machinery for the production of power, fuel and steel, (2) our vehicles for transport-automobiles, locomotives, aeroplanes etc., (3) machine tools and equipment for use in our industries which mostly produce consumer's goods, *e g*, textile, jute, paper, glass, cement, sugar, soap, leather etc, (4) metals like gold, silver, copper, zinc, tin, brass, aluminium, (5) chemicals, fertilizers and drugs, and (6) some high class consumables which may be called luxuries

In the sub-committee of the National Planning Committee and in the Industrial Panels appointed by the defunct Planning Department, no difference of opinion has been found about the immediate objective—which is to attain self-sufficiency, on the present basis of consumption, in the manufacture of goods for which raw materials are available in India No change in the economic or political structure of the country is necessary for this purpose. Private enterprise guided by profit motive can do this job in five years, provided some State assistance is given by way of protection, exchange facilities for purchase of machinery from abroad and arrangement for training of technical personnel There is one danger which should be guarded against—an unholy alliance between Indian and Anglo-American capitalists A National Government will find it much easier to deal with the nationals of the country than with foreign vested interests, because of possible international complications Foreign firms or combines of Indian and foreign firms should be permitted to start new enterprises or expand the existing ones only on the understanding that their interests may be bought off, at any time in future, by Government in pursuance of high State policy Subject to this condition, the Indian business men should, in our immediate plan, be given the fullest facilities for developing Indian industries The history of the sugar industry shows that, if profit is assured, Indian capitalists can work miracles Within 5 years of guarantee of protection the production of white sugar rose to 1·2 million tons It is intended to start 46 new sugar factories in the next 5 years and increase annual production to 1·8 million tons We are confident that, if profit is assured, they can repeat that performance in the field of other industries and displace from the Indian market, in five years, the majority of articles of foreign manufacture by indigenous products

Industrial planning, however, means something very much more than the attainment of self-sufficiency in manufactured goods on the basis of present consumption. A long-term industrial planning has three-fold aims, of which the most important is a wise and planned investment of savings from national income in industrial undertakings with a view to increasing the contribution of industry to national wealth at a predetermined rate. Private enterprise in Western Europe and America has taken between 50 to 100 years to develop their present economic system, where the

* A synopsis of a lecture given by Sir J. C. Ghosh, Kt., D.Sc., F.N.I., under the auspices of the Indian Science Congress at Delhi on 8-1-1947.

major part of the income of the people comes from industrial pursuits. Even with a Government mindful of national interest in Delhi, it will take as many years for private enterprise in India to arrive at a similar state of development. In spite of the praise we have given to our industrialists, the fact remains that the capital invested in our textile, jute, iron and steel, sugar, cement, chemical and other miscellaneous industries did not exceed 250 crores in 1935 ; and in spite of tall talks in certain quarters, it cannot be denied that even under the stress of the war, the index of industrial activity in 1946 increased by not more than 15 per cent over the base year 1935. Russia has shown that these long years of slow progress can be jumped by deliberate national planning of industries In 1928, Russia had a population of 160 million with a per capita income of 162 roubles or 82 rupees India to-day has a population of 400 millions with a per capita income of Rs. 70 in terms of the purchasing power of the rupee in 1942 By 1938, *i.e.*, in 10 years, Russia invested 4700 crores of rupees from the savings of the people in industries, and 1860 crores in transportation, which increased per capita income to 558 roubles, *i e.*, 3½ times in 10 years The Bombay plan suggests that we invest in 15 years 3,475 crores in industries and 1300 crores in transportation in order that we may treble our national income or, taking into account the increase in population, double our per capita income in 15 years. The Bombay Plan is, therefore, far less ambitious than the Russian plan, and is certainly capable of realization provided we have a determined Government broadbased on the popular will to implement the plan. The war has demonstrated how finance can be made the servant of State Policy. In England, every able bodied person above the age of 14 was conscripted for national service immediately after the fall of France Wealth is created as the result of the work of man aided by machines This full employment of the man and woman power increased the yearly national income of England to £9,000 million by 1945—almost half of which was utilized for efforts to win a total war, and the other half utilized for maintaining the standard of living of the people at a prescribed level. Even in India, an alien Government could spend in 1945-46 12,00 crores of rupees as against an average public expenditure of 270 crores in pre-war years. This has meant considerable hardship for people who were not war-employees or war profiteers but there is no sign of bankruptcy. Even the present financial advisers of Government agree that lack of funds would not be a bottleneck in the progress of industrialization specially in view of the fact that our sterling assets of 1,600 crores of rupees may be quickly released to finance the purchase of our capital goods from abroad. The real bottleneck is the attitude of capitalists, and civil servants in league with them, who oppose all industrial production in excess of the proved absorptive capacity of the market and threaten that such production is unprofitable. They forget that planned development ultimately aims at giving plenty to all and not profits to few. This difference in mental attitude has appeared to be fundamental to one who had the privilege of serving in some of the industrial panels of the Government of India dominated by capitalists and also in the National Planning Committee set up by the Congress. It will be a wise policy to affect some compromise between these points of view in the early years so as to make possible the maximum use of our available technical and business talent for development of resources. But once the National Government is firmly on the saddle, there should be no hesitation in enforcing the recommendation of the National Planning Committee that all defence and key industries and public utilities should be owned and developed by the State. These include power in all form, fuel, metals and mineral industry, machine tools, heavy engineering, machine manufacture, heavy chemicals, dyestuffs and fertilizers, transport and communication. We are glad to learn that a beginning has already been made—a fertiliser industry at a cost of 13 crores of rupees is being located in Bihar under the auspices of the Central Government ; a locomotive industry at a capital cost of 12 crores and an aircraft industry at a cost of 5 crores of rupees have been prejected under State ownership and the Central Power Board contemplate commissioning an additional installed capacity of 800,000 KW of power by 1953. We hope that, in spite of differences in ideologies, all our political parties will be unanimous in implementing such constructive proposals Private enterprise can never develop these vital industries as fast as one would wish them to be developed in the larger interest of the country as a whole We have seen Indian industrialists at close quarters, including some of the ablest, and we are convinced that the target which they have themselves fixed in the Bombay Plan, are very modest compared with Russian achievement. Even these cannot be reached in India without the stimulus of a continuously functioning Planning Commission acting as a powerful organ of the State.

The second objective of industrial planning will be to take away surplus labour from land and give them gainful occupation in industries at a predetermined rate. More than 70 per cent of our people live and work as mediaeval peasants on subsistence level and do not produce enough food for the entire population even at a low level of nutrition. It is for our agricultural planners primarily, to take effective measures which will ensure an optimum man-land ratio, and implement a rational population policy. Here the industrial planners can play only a secondary role. In 1942, there were only 17 lakhs of

workers in organized industries, and of these a large percentage was unskilled workers. One of the editors* of SCIENCE AND CULTURE was told by a responsible officer of Foreign Economic Administration in Washington in 1944 that if our 400 million people were to take a year's holiday, their present requirements of food, clothing and other services could be met by 6 million American workers exported into India, but provided with modern tools of production Here is the obvious weak spot in our economy—chronic unemployment and under-employment of unskilled workers. We have a vast reservoir of submerged and unemployed ability in our man-power, and it should be the arduous task of our Planning Commission to develop this latent ability and utilize it to the fullest extent. Abundance of skilled workers is the dominating factor in all industrial development. We had occasion to study the development of Swiss industries 6 months ago. Switzerland does not produce a pound of coal, nor make an ounce of iron or copper or zinc. Yet her electrical, mechanical and power engineering industries, her dyestuff and drug industries, her watch-making and machine tool industries, sell their products in the world's competitive market as fast as their fully employed technicians could produce them. This should give food for thought to those pessimists in India who point out that our material resources are not comparable with those of U S A. or U S S.R, and hence our industrial development could necessarily be very limited. We have large exportable surplus of many strategic raw materials—manganese, chromite, ilmenite, mica, monazite etc., and foreign countries will be always too glad to give us in exchange raw materials which we lack—copper, zinc, nickel etc The Planning Commission should take note of this fact and work on the principle that a limit to our industrial development will ultimately be set only by the availability of intelligent man-power.

The third objective of industrial planning should be the equitable distribution of manufactured goods. The Bombay Planners have so often stated that they do not wish the rich to become richer, that one is tempted to say that they protest too much. In the early years of planning when national effort is mostly directed to resource development, consumers goods will be in short supply. The system of rationing which has now been organized in all the cities of India is on the whole a good thing in disguise. As a logical development, this system, if continued as a policy and handled by an honest and efficient civil service—we lay by special emphasis on the qualifications of honesty and efficiency—should eliminate unnecessary middlemen and effectively curb all exploiting tendencies on the part of agencies purchasing raw produce and selling manufactured goods. Rationing under planned economy should aim at giving each citizen certain minimum requirements of life at controlled or even subsidized prices. In England they subsidize bread by a grant of 90 million pounds, and now sell utility goods in limited quantities almost at cost price. Utility goods in excess of rationed quantity and all non-essential commodities should in future be sold in India subject to a turn-over tax to be fixed by the Planning Commission. Such a turn-over tax forms the backbone of Soviet Finance and was responsible for giving the State a revenue of 106 billion roubles in 1940 out of a total revenue of 178 billion roubles Soviet communism in its newest phase permits payment of wages according to ability but limits severely the purchasing power of high incomes A rapidly accelerating industrial development in the early stages cannot be achieved without some tears. We have an advantage here. Our people are accustomed to shedding tears and we hope they will be less copious as the years roll on. It cannot certainly be achieved without a tightening of the belt for those whose waistline shows signs of expansion—who have grown fat on the riches of the land.

A well-thought out turn-over tax, coupled with a national campaign for saving, and backed by effective measures for full employment will place in the hands of the planning authority enough resources to transform in 15 years a helpless ignorant starving people resigned to the vagaries of fate into a self-reliant, literate, well-fed mass of men united together by a vigorous willing effort into a co-operative team. And therein lies the salvation of our country.

* Sir J. C. Ghosh, during his visit to U S A., as a member of the Indian Scientific Mission.

PROBLEMS OF RECLAMATION OF ORISSA

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INTRODUCTION

ORISSA comprises the British Province of that name consisting of the districts of Cuttack, Puri, Balasore, Sambalpore, Koraput and Ganjam and a number of feudatory States. The details of the area, population, revenue and resources of the states, as far as available, have been provided in Appendix 1. Physiographically, however, Orissa consists of the basins of the three important rivers, Mahanadi, Brahmani and Baitarani and a number of smaller streams (see fig. 1).

These rivers are as erratic in their behaviour as is the Damodar or the Tennessee in the U S. A. was prior to its control by the T. V. A. Unlike the Tennessee, however, where the human settlements are of a recent date, the Orissa river basins have been inhabited, the fertile riparian tracts by highly civilised men from early historical times and the remoter forests by primitive aboriginals from times immemorial The great wealth of extant architectural remains of the Hindu period (Orissa has been almost untouched by Moslems) and other evidences attest to the great prosperity attained by the people and the height of culture reached when Orissa enjoyed independence prior to 1575 A.D.† This is but one side of the tale. History, however, also furnishes us with records of terrible famines and distress as a result of natural catastrophies like floods and droughts occurring throughout the whole historical period.

NATURAL CALAMITIES—FLOODS

"Of natural calamities the most dangerous are floods, inundation from the sea and famines. . . In this (Balasore) district cyclones were recorded on the 27th May, 1823, 31st October, 1831 and again in October, 1832. The most violent cyclones of recent years were those of 1872, 1885 and 1887. The cyclones of 1832 was followed by a severe drought in 1833 and from 1831 to 1833 more than 50,000 people perished in this district. The cyclones of 1885 caused more damage in Katak district than in Balasore. In addition to cyclone and tidal waves, the Balasore district suffers from inundations of rivers. The Subarnarekha, the Burhabalang, the Baitarani, all are liable to periodical inundations, and the flood waters of the Subarnarekha have sometimes travelled twelve miles inland. In 1868 a fortnight's heavy rain caused a flood which was the highest within the memory of men. Another disastrous flood occurred in 1896 when the entire country remained under water for nearly a month. The last recorded great flood was that of 1900 when the water level rose more than 18 inches than all previously recorded heights. In all of these floods practically the whole of the cattle was destroyed though loss of life was not so severe.

"Katak is as much liable to floods and tidal waves as Balasore. It was recorded that after 1830 floods of serious nature occurred at least 22 times :—1831, 1834, 1848, 1851, 1855, 1856, 1857, 1862, 1866, 1868, 1872, 1874, 1877, 1879, 1880, 1881, 1885, 1892, 1894, 1895, 1896 and 1900. The highest flood of which there is any record was that of July 1855 when the Mahanadi rose to an enormous height and the embankmens were breached at more than 1365 places and 52 sq. miles of land were left waste for fear of inundations. The next great flood was that of 1872 when 1135 sq. miles in the Katak district and 1070 in the Puri district remained flooded out of which 600 were under water for a fortnight. Towards the close of the century the most serious floods were those of 1892 and 1896. In 1896 the rivers Brahmani, Baitarani as well as the Mahanadi rose to great height and for fifteen days the flood water remained on the fields destroying the crops. The most terrible cyclone was that of 1885. It burst upon the coast on the 22nd September, 1885 at False Point and a wave 22 ft. high at once submerged the village of Jambu and wiped it away. The storm was specially disastrous in the Jaipur and Kendrapara sub-divisions. In Jaipur alone 300 men lost their lives, 2,447 villages were damaged and nearly 50,000 houses were destroyed. About 2,973 cattles were killed. In the Kendrapara sub-division about 5,000 people

* The author is recipient of a scholarship given by Messrs Adair Dutt & Co, and wishes to thank the firm for their financial assistance. The author is also grateful to Prof. M N Saha for his valuable criticisms and guidance in preparing this paper

† Orissa formed the northern part of the ancient Kingdom of Kalinga and parts of Mahakosala, which were settled by the Aryan conquerors long before the times of Asoke, who annexed the territory after a bitter struggle extending over 8 years (260 B.C.). The cruelties perpetrated in this war were said to be the main factor in turning Asoke's mind towards Buddhism He maintained a viceroyalty in these parts with capital at Toshali which has now been identified with the modern village of Dhauli near Bhubaneswar. The great architectural remains of Orissa consist of the temples of Jagannath at Puri built in the and the temples at Bhubaneswar of earlier dates. Besides, 12th century, the Solar Temple at Konark (14th century) remains of early Buddhist age have been found at Khiching in the Mayurbanj State. Many more architectural remains await further explorations. Orissa remained independent under her indigenous kings right up to 1575 A.D. when it was conquered by the Pathans from Bengal. They were however turned out shortly afterwards by Raja Man Singh, General of the Emperor Akbar and the country was made a Mughal Suba and attached to Bengal. Raja Man Singh is responsible for cutting up the country into a large number of States, some large like Mayurbhanj, other confined to a few hamlets, which were conferred on the scions of the old nobility, some of whom were already in possession of them and the relations and dependants of former ruling dynasties. The country was conquered by the Mahrattas in 1750 from whose rule it passed on to the British in 1803. Neither the Mahrattas, nor the British introduced much change in the internal administration. For a detailed account see R. D. Banerjee's History of Orissa, published in two volumes. It is worthy of notice that no great architectural or constructional work was undertaken during nearly four centuries of Mughal, Mahratta or British rule.

were drowned, 10,000 cattle lost, 11 villages were completely swept away. The best rice growing tracts in the Kanika estate were converted into brackish wastes. The next important cyclone was that of 1890, when a tidal wave affected a considerable part of the Kujang estate. All standing crops were destroyed and the tanks and wells filled, with brackish wastes.

"Puri, the third district of the Mughalbandi, is also liable to river floods and tidal waves . . . The years 1872, 1892 and 1896 were remarkable for floods. The most serious inundation was that of 1866 when 275 sq miles were submerged from five to forty-five days. The water was not less than three feet deep at any place and in certain villages it was 10 feet in depth.

The greatest famine of the British period was that of 1865-66. Nearly 1,00,000 died of starvation and diseases. The next famine was that of 1897 on account of excessive rainfall and floods.

"During the British period Katak suffered from famine in 1800, 1808, 1809, 1817, 1828, 1836, 1837 and 1842. But the greatest famine was that of 1865-66 In 1866 floods of the Mahanadi destroyed the crops in the district and half of Katak was devastated. In January 1867 forty deaths were reported every day on the average from starvation. The scarcity was not over till 1868. Like Balasore, Katak suffered from another severe famine in 1896-97

"In the Puri district, which is more fertile than the others the most severe famine was that of 1865-66. The

FIG. 1 Important River Basins of Orissa (that of the Subarnarekha has also been shown)

FAMINES AND SCARCITIES

"Generally speaking, the whole of Orissa, is barren and unproductive compared to the rich deltas of the great rivers and the Malabar country. The yield of the harvest is also poor and irrigation is required in many tracts to produce any crop at all. Consequently Orissa has suffered from famine from time immemorial. Famines were of frequent occurrence before the opening of the railways from Madras to Puri and from Puri to Calcutta. Famines of less severe nature occur with regularity even now and are called *Scarcities* in official records. The greatest famines of Orissa of the Maratha period were those of 1770 and 1780. In 1770 rice was sold at less than two seers to the rupee and thousands of people died. This was fifty to sixty times the normal price of rice in those times. Land lay untilled for years and in 1780 most of the country was waste. There was famine in 1792-93 and again in 1803.

scarcity began in this district in October 1865 Crops failed in 1864, there was regular drought in 1865, and standing crops were destroyed by inundations in August 1866. Therefore the famine was more severely felt in this district than in any other part of Orissa—thousands of people died both from starvation and through the eating of uncooked rice by paupers" (R. D. Banerjee's History of Orissa, p. 325-328).

This picture remains much the same even today. A preliminary estimate of drainage done by Mr J. Shaw, Executive Engineer has placed the money value of damage during a period of 29 years between 1910—1938 at about Rs. 3½ crores.

The maximum losses due to extraordinary floods in a single year have been some times as high as

Rs. 66 lakhs. The losses chiefly occur by damage to or destruction of crops, heavy cattle mortality, deterioration of fields due to deposits of sand, damage to roads and other evil effects. This is but a very modest estimate and no calculation is possible of the loss of and damage to human lives entailed in these floods. The droughts mostly affect the upper valley where they also occur with as much frequency as the floods in the lower and make it almost impossible for agriculture to be carried on in a land where measures for irrigation hardly exist

Problems of Orissa

Inspite of the fact that the river valleys in Orissa have been inhabited by civilized people for over two thousand years (fig. 2), the problems affecting them have never been tackled in a comprehensive way. As mentioned earlier there are mainly two groups of people living in Orissa, the aboriginals and the non-aboriginals, most of whom are Oriyas possessing Aryan culture. The Oriyas have been almost entirely dependent on agriculture and have kept mostly to the river valleys where it can be carried on conveniently. With the increase of population, the density of population of the riparian tracts have multiplied, ultimately leading to minute fragmentation of the holdings. The aboriginals on the other hand, pressed by the Oriyas have moved to the hills where in the secluded forests they could carry on their primitive food gathering and hunting economy. The large number of great temples, their elaborate architecture point to the fact that the Orissa people must have possessed enough skill in mining, architecture and premachine day industries. Old accounts of Orissa also indicate that the Oriyas knew the value of minerals, particularly the metals and gemstones that are found in their country and carried on a certain amount of trade in these materials. But the industries do not appear to have been extensive nor did the people appear to have made any serious effort to harness their turbulent rivers. From 1803 the country has been under occupation of the British who could have developed the mineral and forest resources. But nothing has been done so far, as they have been wedded to a general policy of looking upon Orissa as also other parts of India only as a source of raw materials Orissa therefore continues to be poor inspite of her varied mineral, forest and agricultural resources. Though the great Tata Iron and Steel works have their factory located at Jamshedpur in the Singhbhum district (formerly in Bengal, now in Bihar) the Garumahisini hills from which they draw their iron-ores are located in the Orissa State of Mayurbhanj. But the Oriyas are employed here mainly as unskilled labourers. The people of Orissa have not yet reached the level of other provinces of India where people can think of development of

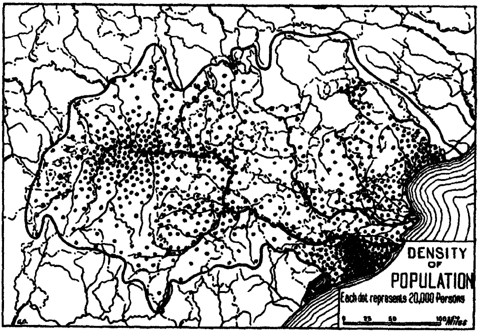

Fig 2. Population distribution in Orissa (conjestion is along river valleys where floods are most destructive)

natural resources of the country for Industry and can undertake them with ability and efficiency. It is probably not an exaggeration to say that the average man in Orissa has the smallest income of all the provinces in India.

The crying need of this backward region are, therefore, many. Large portions of Orissa, particularly the deltaic region and the riparian tracts can only thrive on agriculture. But agriculture in Orissa is in a precarious condition for the delta has no security from floods and droughts which occur too frequently. Owing to soil erosion the rich agricultural lands, particularly on the slopes of hills are losing their fertility. Forests which with a sound policy and vision can be made extremely productive as in Sweden are being indiscriminately cut down Only one of the abundant mineral ores, iron has been partially developed and the result has been the T. I. S. Co. A host of other minerals can be similarly developed All these possibilities of development are again tied up with the question of communication. Orissa is served by 501 miles of B N. Rlys. but these only touch a very small part of the country. Road communication is almost as good as non-existent and river communication is hampered by floods during the monsoon period and entirely ceases on account of drought during the summer months (see fig. 3).

THE PHYSICAL MAKE-UP OF ORISSA

The Catchment of the Mahanadi —The principal river basins which together go to make up Orissa has been shown in fig. 1. Of these that of the Mahanadi is by far the largest having a catchment area of 51,000 sq. miles and an annual average rainfall of 60″. It compares favourably with the Tennessee basin which has a catchment area of 40,000 sq. miles and an annual average rainfall of 47 inches. The catchment of the Mahanadi may be divided into two parts, west and east of Sonepur The upper catchment area is nearly circular in shape with a diameter of 250 miles and with an area of 40,000 sq. miles. It may be said to stop opposite Sonepur below the confluence of the large tributary Tel with the Mahanadi. The middle catchment may be said to extend from Sonepur to Naraj. It is irregular in shape, has an area of 8,000 sq. miles and it serves as the bottleneck to the delta region at Cuttack from where the river spreads out in the shape of a fan. Major part of the upper region is known as Chhattisgarh and comprises the districts Drug, Raipur and Bilaspur of the Central Provinces and some small States. The entire catchment except the delta is a plateau averaging 1,500 ft. in height. After flowing for a distance of 500 miles through this undulating terrain the Mahanadi enters its deltaic tract at Cuttack, which like Cairo is situated at the head of the delta but unlike the latter is inside the fork. The mainstream divides into two chief distributaries the Debi and the Mahanadi and ultimately meets the Bay of Bengal in a number of split channels. The Mahanadi, from the source to the mouth measures 550 miles and is shorter than the Tennessee by 350 miles. It is fed by a number of large tributaries in its upper catchment area. Of the left hand tributaries, the Seonath, Hasdo, Mand and Ib are the most important (see fig 1) whereas the Jonk is the largest right bank tributary The Tel is the only large tributary which joins from the right in the second section of the catchment. Details of lengths of these tributaries, their catchment areas and the slopes are shown in table 1 (p. 364) and the vertical profile drawn in fig. 11.

Brahmani and its catchment.—The Brahmani has a much smaller catchment area of 15,000 sq miles It is seomewhat less than one-third that of the Mahanadi catchment (51,000 sq. miles) but more than double that of the upper Damodar catchment (7,000 sq miles). It is of an oval shape with a constriction in the middle. The catchment has a maximum length of 246 miles and a width of 58 miles. It is a shallow valley and is also undulating like the Mahanadi valley. The Brahmani has been formed by the combined waters of the South Koel and Sankh rivers both of which rise in the Ranchi district at elevations of about 1,800 ft. The confluence is at Panposh in Gangpur State and the stream flows almost parallel to the Mahanadi entering the delta in the Cuttack district The Brahmani is 345 miles long

The catchment of the Baitarani.—The Baitarani has a catchment area of only 4,000 sq. miles which is about one-fourth that of the Brahmani It is also in the plateau area and is roughly circular in shape, with a diameter of 61 miles. The Baitarani takes its rise from the high lands in Keonjhar at an elevation of about 1,600 ft. and enters the delta along the northern border of the Cuttack district. It is only 142 miles in length and its course is also parallel to that of the Brahmani.

		Area in miles		Discharges in Cusecs (at the head of delta)		
	Length miles	Catchment	Deltaic area	Max.	Monsoon normal	Min.
Mahanadi	550	51,000	2,500	1,570,000	300,000	204
Brahmani	345	14,000		650,000	90,000	130
Baitarani	142	4,000	700	400,000	25,000	small
Damodar	340	7,690*				
Tennessee	904	40,600		297,000	25,000	

* Up to Rhondia.

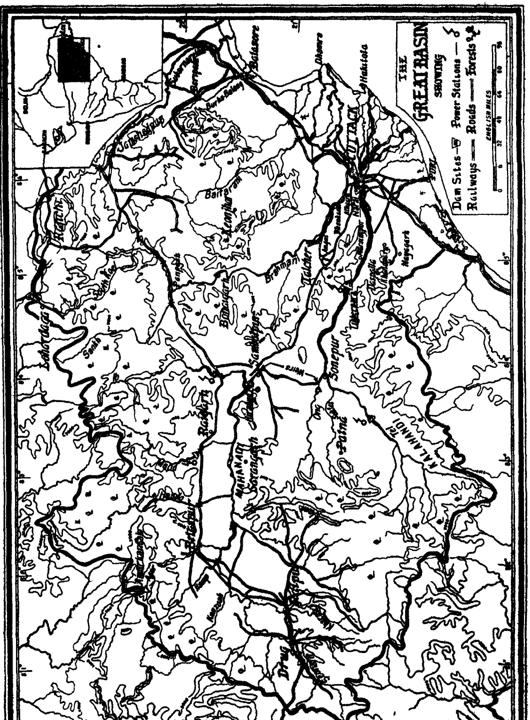

Fig. 3 Communication hardly exists in Orissa The dam sites are those suggested in the reports of the Orissa Flood Advisory Commission and the project of the Central waterways and Irrigation Commission

Geomorphic features and geological formations A south western offshoot (Saletekeri) of the Maikal hills belonging to the Satpura Range of Central India separate the basin of the Wainganga which flows into the Godaveri from those of the Orissa rivers The northern periphery of the Orissa river basins is formed by the Mainpat and the Netrahat plateaus and finally by the high lands of Singhbhūm towards the northeast To the south the Bastar highlands stand between the Mahanadi and the Indravati river basins and the same ridge is continued eastwards in a zigzag (under different names) up to the Chilka lake along the coast The area thus enclosed by the peripheral highlands is itself the meeting ground of the Eastern Ghats proceeding from south with the Satpuras stretching from Central India The strike the plateau are Bankasamo (4 182 ft) and Karlapat (3 981 ft) in the Kalahandi State Goaldes (2 500 ft) in Daspalla Mankarnacha (3 600 ft) in Bonai Gandhamardan (3 480 ft) in Koenjhar Malyagiri (3 900 ft) in Pal Lahara and Meghasani (3 800 ft) in Mayurbhanj

Along the coast for a varying distance of 25 to 50 miles there stretches a delta formed jointly by the Orissa rivers that is almost flat A view of the country as seen from the delta looking towards the highlands has been shown in fig 12

GEOLOGY

The geology of Orissa and the Chhatisgarh region has been reproduced in fig 4 The

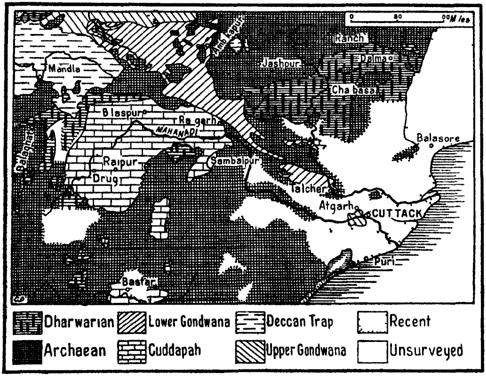

Fig 4 Geological map of Orissa and adjoining areas (From the Geological Survey of India)

of the Eastern Ghats rocks is N E S W while that of the rocks composing the Satpuras is W N W E S E Both these trends are shared by the rocks of the Orissa plateau and it is reflected in their grains As a result the plateau has been divided into roughly rhomboidal blocks separated by valleys striking almost N E-S W or N W S E Later complications in the drainage pattern have however been introduced by subsequent tectonics, particularly during the Gondwana period The average height of the plateau is 1 000 ft. in the Chhattisgarh region and 2 000 ft further east Several notable peaks in Chhattisgarh plains are mostly composed of sand stones and limestones of Cuddapah (pre Cambrian) age There is also a spread of Gondwanas stretching from the Hasdo valley to the Brahmani roughly along the northern bank of the Mahanadi These consist of shales sandstones and coal seams The rest of the area including the high ridges are composed of igneous and metamorphic rocks granites and schists of early archean age as well as schists, limestones and quartzites of late archean (Dharwar) times A large part of this area (left white) is yet to be mapped and those that have already been

covered should have to be scrutinized Besides the above, an extensive capping of laterite is found over most of the crystalline rocks The deltaic region and the flood plains are capped with recent alluvia

Natural Resources

The geological formation in Orissa and Chhattisgarh are known to contain a variety of economic mineral deposits varying in size from replacement pocket lenses and fissure fillings up to extensive beds The following may be mentioned here

Metallic ores—Iron, Manganese Aluminium, Chromium Vanadium Titanium, Copper, Lead and Graphite

Fuel—Coal of the Bituminous variety

Flux—Limestone

Refractories—Kyanite, Quartz, Fireclay

Other minerals—Mica, Asbestos, China Clay, Ochres (yellow and red)

Ballast materials

The areas where the above are located and the possible industries that may be started with their help have been indicated in fig 5 It must however be borne in mind that the map is a purely suggestive one In the absence of detailed information regarding the reserves of these minerals and their quality it is impossible to say anything about the utilization It is almost a tragedy that Orissa and the Chhattisgarh region though infinitely rich in minerals has been so little surveyed by the geologists and the mineralogists

Besides minerals Orissa is also rich in a host of forest products Large amounts of Sabai grass and bamboo (both valuable for paper and newsprint), lac, resins and silk cocoons, mahua for alcohol, barks and roots for tanning purposes and medicines and kend leaves for manufacturing native cigarettes are produced every year Light timber and firewood bring large annual revenues and cotton is grown in Chhattisgarh But no exact evaluation of the forest products is possible without a detailed botanical survey nor can its scope be foreseen

Agricultural resources include a variety of cultivated crops like Rice, Wheat, Millets, Potato Sugarcane and Pulses Fibres include cotton and jute Tobacco is also raised in small quantities

Hydro-Meteorology of Orissa

Rainfall and Runoff—The rainfall in the catchment areas of the Mahanadi, the Brahmani and the Baitarani is mainly due to the monsoons which provide 85 per cent of the total precipitation It is usually precipitated during the months May to August From a study of the rainstorms for the last 35 years, Prof P C Mahalanobis has worked out an average track for the monsoon currents (fig 6)

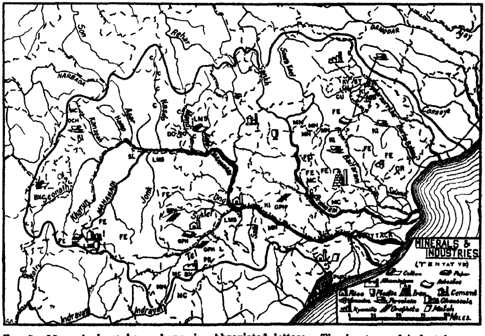

Fig 5 Minerals have been shown in abbreviated letters The location of industries are merely rough approximations

It lies across the middle of the catchment areas of the Baitarani and the Brahmani, but passes through the north-central part of the Mahanadi catchment The amount of rain anywhere in Orissa is determined over a number of years, the Orissa Government will be well advised to start at least one well-equipped hydro-meteorological laboratory* instead of depending on outside experts.

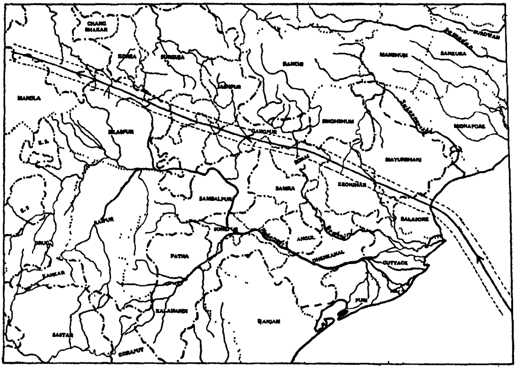

FIG. 6. The average track of rain storms during the years 1891 to 1928 as worked out by Prof. P. C. Mahalanobis, (*Sankhya* Vol 5)

mostly by two factors, the local relief and the position with respect to the track of the storm. The rain-bearing storms enter the coast near about 25 miles north of Balasore and proceed north-westwards towards Central India. The actual distribution of rainfall over Orissa has been shown in fig. 7. It will be noticed that the maximum fall is encountered to the north of the Mahanadi, in the north-central part of Orissa, which lies across the path of the storm tract where the relief is highest The rainfall varies from 65″ to 75″. In the coastal districts, where the monsoons make their first onset, the rainfall varies from 55″ to 65″ on account of the low relief. Again the upper catchment area of the Mahanadi, the Chattisgarh region does not also receive as high an amount as the north Central part because of its remoteness from the track of the storms. In a localized region, in the valley of the Mahanadi, between Sambalpur and Sonepur, the rainfall exceeds 75″ where the Bay of Bengal monsoons are reinforced by the Arabian Sea monsoons coming from the west south-west. In view of the importance of the accuracy of such data and the necessity of knowledge of their variation from month to month

* Rainfall and stream Gauges The engineers must gather, at least daily, sufficiently complete information regarding drainage basin so that they can estimate with considerable exactness the volume of water that is flowing and will be flowing for several days in all the principal streams throughout the wastershed To accomplish this requires a comprehensive network of rain and stream gauge stations

This network is basic in the success of the hydrological phases of the water project operation The extent of the network of rain gauges will vary with the size and topography of the drainage area. In general, in mountainous regions where variations in rainfall are most pronounced, the number of stations per unit area must be greater than in flatter countries where geographic influences are not so important. In water project operations, as in other hydrologic investigations, the smaller the area of interest, the larger the number of rain gauges required per unit area.

In the entire Tennessee Valley, the density of rain gauges is one to each 80 sq. miles (there should be about 637 stations on this basis in the Mahanadi catchment). The actual number is said to be only three In the mountainous eastern sections, the sq. miles per gauge approximate half the average; and in the rolling western portion of the basin at lesser elevation, the density is about 130 sq. miles per gauge. The network includes sufficient recording rain gauges so that intensity and duration of storm rainfall are known. Gauges are located with respect to topography so that rainfall at high as well as low altitudes is measured. (Fry, A. S. and Chowalter, A. K.—Hydrometeorology, Section XIII of Hand Book of Meteorology, p. 1007).

Let us assume that the runoff for the whole catchment is 55.* This does not appear to be compared with the 110 million acre feet of precipitation in the Tennessee Valley of which 44 million

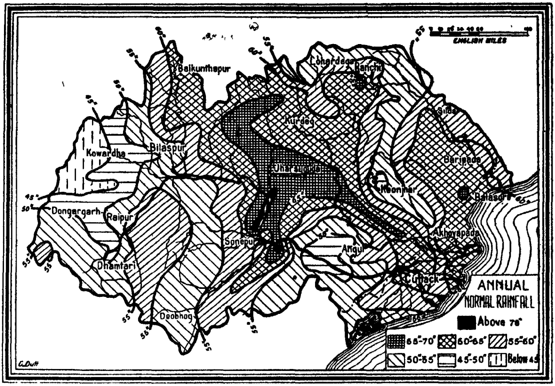

Fig 7 Distribution of Rainfall in Orissa during the whole year.

excessive since the upper and middle part where 90 per cent of the precipitation takes place, is considerably sloping It follows that the total precipitation is nearly 160 million acre-feet of which 88 million acre-feet of rain reaches the river annually. About ¾ of this amount falls within the four months of the monsoon and we easily see that this gives as an average monsoon discharge of $\frac{66 \times 10^6 \times 4.3 \times 10^4}{10^7} = 3 \times 10^5$ cusecs as given in the Table This may be acre feet (40 per cent) is the average runoff. The Mahanadi has its source at an elevation of 1,100 feet, so that the average head through which the water in the river has to fall before meeting the sea may be taken to be 500 ft. The Mahanadi therefore dissipates every year (88 million × 500) or 44,000 million KwH of energy, which is three times more the energy (13,200 million KwH) which has been harnessed from the Tennessee. How much of the total energy dissipated by the Mahanadi can be harnessed is a matter for detailed investigation. But if we take a conservative figure of 20 per cent, about 9,000 million KwH would be ultimately available and this will give nearly 600 units of energy per capita for year for the Orissa people.* If this energy can be properly utilized for running industries, Orissa can become as prosperous as France.

* From Professor Mahalanobis' figures it is determined that the average percentage runoff for the Mahanadi catchment, *i.e.* river flood volume compared with volume of rainfall in the catchment, decreases as that period increases The increase or decrease of percentage runoff with the extension of the period for the same amount of rainfall is doubtful although Mahalanobis considers that the percentage increases with the period Some average results were —

For 3 days' rain	1,390 kilocusecs	69%	runoff
,,	3,086 ,,	44%	,,
For 4 days' rain	1,275 ,,	68%	,,
For 6 days' rain	1,134 ,,	76%	,,
,,	2,190 ,,	47%	,,
For 10 days' rain	862 ,,	73%	,,
,,	1,665 ,,	51%	,,

(Quoted from third Interim Report of the O. F. A. C., February, 1942, p. 16).

* The exact determination of the total energy dissipated by a river system (main river and its tributaries) is a very difficult problem. Theoretically the total energy dissipated measured in kilowatt hours is given by

$$E = 9.8 \times 10^4 \int_{h_1}^{h_2} q \, dh$$

where q is the *average* flow of the stream per *second* in (meters)^3, h is the height in meters, h_2 is the level from which the water starts and h_1 is the level where it stops.

The total precipitations in the Brahmani and the Baitarani assuming 60 inches of rain as the average would amount approximately to 44 million acre ft and 12 million acre ft. respectively. The energies dissipated by them would also amount to (24 million × 900) or 21,600 million KwH for the Brahmani and (6½ million × 800) or 5,200 million KwH for the Baitarani.

It appears that the Mahanadi Basin and other river valleys are not provided with sufficient rain guaze stations and the number of stream guaze stations appear to be only three, one at Naraj for the Mahanadi, one at Jenapore for the Brahmani and one at Akhoyapada for the Baitarani. From the data supplied by these stations it is impossible to work out the water balance of the area throughout the year which is the *sine qua non* for any scientific planning for constructive works on the multipurpose basis What is given here is not claimed to be more than a rough guess and should be taken with certain amount of reserve

We have given a rough idea of the hydrology of the Mahanadi basin and the effects which it produces

If the figures are given in British units, *i e*, flow in cft per sec., the height in ft

$$E \times \Sigma 8\,2 = 10^3 \int_{h_1}^{h_2} q\, dh$$

The estimation of total E for a river system for any particular year is a matter of extreme difficulty and requires an elaborate Hydrometeorological Organization. The flow of the river and its tributaries at selected points, which should be as many as possible, should be observed by stream gauges throughout the year

The quantity can also be obtained from measurement of precipitation over the area This can be obtained by maintaining a large number of rain gauge-stations over the whole area, and measuring the runoff with the aid of water flow data A knowledge of the contour of the river-basin, nature of the soil and of the slope is very essential.

The quantity of E will vary from year to year depending on the flow The variation may be some times very large.

The determination of the amount of energy which can be physically harnessed is a matter of great difficulty It depends upon a geological and topographical survey of the whole basin and discovery of proper dam sites How much of the energy can be economically utilized is a matter of further investigation, for which soil, mineral and forest resources have to be investigated in great details

To take an example : The Congo River in tropical Africa is one of the biggest river systems in the world, in fact the biggest, next to the Amazon. It has a length of 3,000 miles, and carries an enormous amount of water. Recently a Belgian officer has carried out a detailed hydrometeorological survey of the basin and finds that it can give an average power of 135±27 million kilowatts, which means an annual energy yield of 1200±240 billion (10^9) kwh. This is nearly three times the electrical energy used in the whole of U S. A. But only 7 per cent of this energy can be economically developed.

Probably our Ganges-Brahmaputra system of river dissipate the same order of energy, but its determination will depend not only on the hydrometeorological survey, but also on snow survey of the Himalayan glaciers. How much of it can be actually harnessed, and how much can be economically utilised are at the present state of our knowledge only matters of guess.

We have also given an idea of the mineral, forest and agricultural resources of this area. From a perusal of them it must have appeared that here we have a country of enormous potential resources imaginable and minerals which with the aid of the power that can be harnessed from the rivers will render the country a smiling garden On the other hand as we mentioned before the present day Orissa has the smallest income of all the people of India and the province the smallest budget of all the Indian provinces, running her administration with large subventions from the Central Government Is it possible to work out a complete scheme of reclamation?

Comparison of the Mahanadi with the Tennessee Valley

From a study of the physiography of the Mahanadi Valley, one cannot but be struck with the close similarity which it bears to the Tennessee Valley before the work of reclamation was started there. The area of the valleys, the rain fall and runoff are almost identical, the advantage being on the side of Orissa In the Tennessee Valley also the same problems were encountered, necessity of control of floods, prevention of the soil erosion, improvement of agriculture, exploitation of the mineral and forest resources and what is most important harnessing of the devastating waters flowing through the streams to useful work (hydro-electric power development). We are also impressed that if the problems of Orissa are ever to be solved, it must be on the same lines.

The story of the Tennessee Valley reclamation has been told in many places but it may be repeated again for the interest which it has got for the present problem. The difficulties which were encountered here were of all kinds, political, economic and technical and the same difficulties may be encountered in Orissa The river flows through seven States in U.S A and for the success of the scheme it was felt necessary that the entire valley should be treated as one regional unit This was not possible because under the Federal Act agriculture and irrigation, and development of industries were State-subjects. Any scheme which involved the States had to receive the prior sanction of all of them

It is obvious that in a democratic country like U.S.A. such an agreement between the seven States, each of them autonomous and fiercely jealous of its rights and prerogatives could not be thought of and as a matter of fact it was not forthcoming for a long time. The hydrographic survey of the valley was carried out between 1900 and 1925, by the U.S.A. army engineers, and possibilities of multipurpose development were foreseen. At last through efforts of Senator Norris, a bill was passed sanctioning the

creation of an Authority for the reclamation of the valley. But here a fresh difficulty arose As soon as it became known that generation of hydro-electric energy was an integral and essential part of the scheme, private owning electrical supply companies in the different States raised a hue and cry, for according to the American Constitution, they argued, development of industries was always to be left to private enterprise. Their agitation was so intense that President Hoover, himself a Champion of private enterprise, took no action on the bill though it had passed both the Houses It was only when President Roosevelt came to the White House in 1932 that any action could be taken. He had devised the New Deal in order to cope with the unemployment problem arising out of the great depression of 1931 and sought to solve it by launching a great number of constructive works The Tennessee Valley scheme was one of these, as it would give employment to thousands of people. But in order to get over the difficulties of Constitution, he had to invent a dodge ; though agriculture and development of industries were State subjects, navigation was a federal one and it was through its back door that he pushed the scheme for Tennessee Valley reclamation. In his message to the Congress he recommended the measures in the following words :

> "That the T.V.A shall have power to construct such dams and reservoirs in the Tennessee River and its tributaries, as in conjunction with Wilson Dam, and Norris, Wheeler and Pickwick Landing now under construction, will provide a nine-foot channel in the said river and maintain a water supply for the same, from Knoxville to its mouth, and will best serve to promote navigation on the Tennessee and Mississippi River drainage basins."

Though the Tennessee Valley Authority was launched through the back door, its activities were never confined to navigation alone, but it was a completely multipurpose scheme. Difficulties were placed in the work of the Authority by the States and a large number of law suits was brought against the Authority by Holding Companies controlling supply of electricity in the seven States. But thanks to the support given by the President and the Congress, the Authority was able to fight down these law suits successfully and carry out their programme.

In the carrying out of all the programmes of Orissa we anticipate a large number of difficulties. Owing to historical reasons the Valley of the Mahanadi is divided into the British province of Orissa and a very large number of feudatory States with certain powers of autonomy (fig. 8). It is quite certain that in the framing of a full multipurpose scheme with the basins of entire rivers as one unit, political difficulties with these States are sure to crop up. But means must be found to fight them down. Now co-ordination means strength and prosperity, division means weakness and poverty, as the history of every country and that of Orissa in particular demonstrates. Before the Mughal conquest of Orissa, she had been a centralized State for over four centuries and under her own independent emperors, she had kept her power and

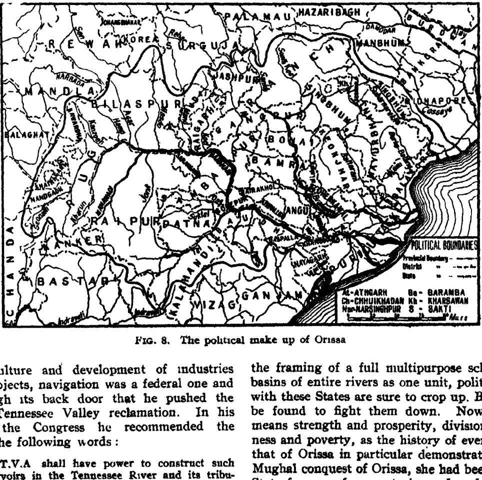

FIG. 8. The political make up of Orissa

independence intact when other parts of India were being overrun by the Turkish invaders. She had attained to wealth, power and prosperity which is attested by the unique remains of grand temples, as also by the fact that her emperors measured their arms on equal terms for three centuries with the Pathan rulers of Bengal, the Bahamani rulers of the Deccan and with the rulers of the Vijaynagar empire. This was due to the fact that the country was not cut up into a large number of autonomous States uncontrolled by any Central Authority, but could be united for a common great purpose by the leader of the State. The decline came when the Mughals destroyed the central power and divided the countries amongst the feudatories The situation worsened from 1803 when the province passed under the control of the British who following their usual game of *divide at impera*, not only kept the Mughal system

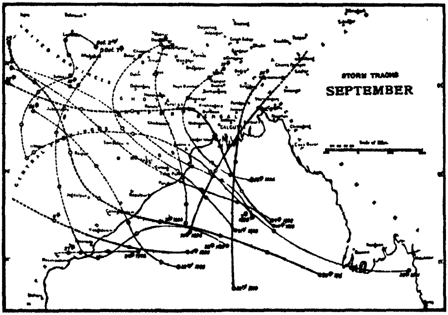

FIG. 9 The map shows that the depression has a definite trend and velocity both of which can be predicted at least 3 to 4 days ahead thereby helping in flood forecasts and flood-prevention operations (Published by the India Meteorological Department, 1925)

as it is, but created fresh political problems by splitting the province into the regulation districts and non-regulation tributary States and endowing the rulers of the States with powers which they do not appear to have possessed under the Mughals.

Problems of Flood Control

The population map for Orissa (fig 2) shows the highest concentration in the deltaic region. It is the deltaic region again which suffers from frequent floods. The floods are therefore of greatest concern to the people of Orissa. The deltaic region in Orissa being the first to encounter the monsoons, receives rain prior to the precipitation in the catchment area. During the monsoons, peak flood discharges are extraordinarily high; figures of 1,571,000 cusecs in the Mahanadi, 650,000 cusecs in the Brahmani and 400,000 cusecs in the Baitarani have been worked out during times of catastrophic floods. The average maximum during monsoon period are 300,000 for Mahanadi, 90,000 for the Brahmani, and 25,000 for the Baitarani. Such tremendous amounts of water are discharged into the river-channels at a time, when the deltaic channels themselves are in a swollen state Reports of the Orissa Flood Advisory Committee indicate that the channel capacities of the distributaries of the Mahanadi, all combined, at a distance of 25 miles from Cuttack is only half that of the Mahanadi at the delta head This is because up to Naraj, the river flows in a deep gorge, having a large capacity and though the level reaches sometime 60 ft. from the lowest point, it does not overflow the banks It may be presumed therefore that about half of the flood discharges of the rivers have to flow in a sheet over the delta. Further complications as to the quick disposal of this flood water are brought about by a number of agencies, man made and artificial. The floods in most cases synchronise with the heaving up of the sea by 3 to 4 feet due to the impact of the monsoon winds. This raises the sea level and thereby reduces the slope of

the land. A littoral drift also sweeps the coastal margin of the deltaic region forming transverse sand ridges, across the mouths of the streams This has diverted some of the streams from directly falling into the sea and made them traverse a longer course before an opening could be available across the ridges. A delay in clearance is thus entailed Unjudicious layouts of road, railway and zemindary embankments and canals have further complicated the problem by tampering with the drainage

The age old method of flood prevention is to embank the rivers But the construction of embankments cannot be undertaken for the whole of the delta

FIG. 10. The Radar photograph of a rain storm which can be located long ahead of its appearance over the station (*Science News Letter*, Nov 1946).

nor would it be advisable for the agricultural tracts to be deprived of the benefits of a controlled water supply Even if embankments are constructed they cannot be made uniformly strong ensuring the prevention of breaches throughout the entire length Any incidental breach through any weak point will allow all the flood water of that particular channel to escape and thus spell severe disaster as has very often happened Moreover throwing up embankments in one particular locality will necessarily mean deepening the floods in the adjoining area. The worst part of the embankment is that they confine the deposition of silt in the bed itself, so that the river level tends to rise higher and higher till the river bed is actually higher than the surrounding country. But the level of the embankments cannot be raised indefinitely, consistent with the competency of the structure to resist flood pressure, so that ultimately a breach becomes inevitable. The river, then takes a new course, cutting through populated areas. carrying off cities and villages, and fertile soils as has very often happened in this region.

The most sensible step, should it prove practicable, would be to arrest the excess water in a number of reservoirs in the upper valley up to Naraj at the delta head, during heavy floods and to release it throughout the year In other words to store up a large fraction of the total runoff and utilize it in various ways. The total average monsoon discharge at the delta head of the Mahanadi would amount to 88 million acre ft (*i.e* , 55 per cent) of the total precipitation in the catchment * Averaged over the whole year, it gives a mean flow of 120,000 cusecs through the Mahanadi and her channels How much of it can be allowed to pass through the channels without the incidence of floods have to be thoroughly investigated. So that the rest of the amount will have to be stored for purposes of flood prevention. An attempt has been made in the reports of the Orissa Flood Advisory Committee to determine the storage necessary for flood prevention. It is being reproduced here.

FLOOD PREVENTION MEASURE SUGGESTED BY ORISSA FLOOD ADVISORY COMMITTEE

"Puri district is watered by the Koakhai and its branches and is taken as the criterion since we have a large system of embankments, escapes and rivers here with sufficient information to make the position clear. It has been observed that whatever flood is safe for Puri district is also amply safe for the rest of the delta.

"Bellevue gauge on the Katjuri at Cuttack town is the warning gauge for Puri district. When this gauge reaches 20·00 floods may be said to have begun in Puri district and at about 21·50 the flood escapes start working ; at 24·00 on this gauge, the escapes are passing 6 inches to 2½ ft. of water and the flood is about 3½ ft., below the crest of the embankments as at present existing. The maximum gauge reading was 27·80 in 1892 and the 1937 flood was 27·25. The amount of flood passing with gauge at 24·0 I should consider as the safe limit beyond which it

* For the designing of any scheme we should not only know the average monsoon discharge but the variation of the discharge from year to year and over as long a period as possible We understand that the Bihar and Orissa Government had commissioned a famous scientist to work out all these figures from the rainfall data nearly fifteen years ago but the results of this investigation though ready do not appear to have been made available either to the Government Engineers to work out the Hirakud Dam Project or to the public. Further, not only analysis of rainfall data but the measurement of flow through the mainstream and the tributaries over a number of years are also required to work out any scheme. This requires hundreds of stream gauging stations over the area but we are informed by the O. F. A C that only three such are in existence It passes our comprehension how any reasonable figure for the run-off (average as well as the maximum during the periods of flood) could have been worked out on such slender basis.

would be desirable to restrict floods if possible. From a study of past records of damage it would appear that some slight damage is to be expected after the gauge reaches 23'00 and bad damage when over 25 00 With a gauge of 24 5 as happened on 27th July, 1937 water passed but causing no damage to houses. A prolonged flood at this height will of course cause damage to crops in low lying areas and affect houses About 23'5 seem to be the gauge where the floods reach house walls and the lower class low lying houses are affected.

Flood Volume to be Controlled

"With Bellevue gauge at 24 00, Naraj gauge above *wire* on rising flood has an average reading of 89 0 and according to Rhind's discharge table for this site the discharge would be about 1,140,975 cusecs. The 1855 and 1834 floods which reached on Naraj gauge 93 36 and possibly 93 60 (unknown) are the highest floods on record but are too extraordinary to be designed for Considering the highest floods from 1872 (92'10), 1892 and 1896 (92'10), 1920 (91'88), 1933 (91'85) and 1937 (91'50) we may take 92'10 as being the maximum not likely to be exceeded From the examination of the time and height curve of the maximum floods it is found that the average gauge reading for the period over 89'0 for a 92'10 flood is 91'0 which from Rhind's discharge table gives 1,349,310 cusecs Examination of the highest floods shows that provision must be made for about 7½ to 8 days, say eight days of such conditions so that the necessary reservoir provision is (1,349,310—1,140,975) 8 x 24 x 60 x 60 = 1,44,000 million c ft

"Considering controlling floods at a lower level say, half way between the start of a real flood at 20'00 on Bellevue and 24 00 beyond which as noted above it is not desirable to go The escapes are then passing nil to 1'3 ft. of water over their crests With Bellevue at 22'00 Naraj gauge on a rising flood is about 88'00 with discharge 1,016,102 cusecs and the average gauge height for such floods from 88'00 to 91'1 is 90'25 with discharge 1,246,625 Except for the 1896 flood which was above 22'00 on Bellevue for fourteen days there is no record of a period of over 9 days since 1894. So we may assume a nine day period . . The volume of flood to be controlled will therefore be (1,246,625—1,016, 102) x 9 x 24 x 60 x 60 = 1,79,500 million c. ft. This exceeds the previous figure by 35,000 million c. ft."

The above estimate therefore indicates that if provision for 7,804 acre ft. of storage is made, it can substantially reduce flood within a safe limit.

Total Lack of Data

The above extracts show that the O.F.A.C. had very little data to go upon, and their findings

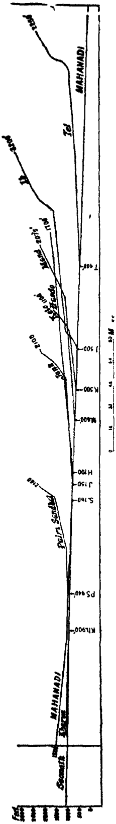

FIG 11 Vertical profile of the Mahanadi and its tributaries. The actual direction of flow of most of the tributaries have not been indicated. The exact level at which they rise and the point where they join the main stream have however been correctly represented.

are more in the nature of a guess than a conclusion based on sound data.

It is rather strange that though the Bihar and Orissa Government have appointed from time to time Flood Advisory Commission consisting of big experts in Irrigation and River Development they have never taken seriously their advice of working out the water balance of the basins and particularly the relation between the incidence of monsoon precipitation in the upper catchment area and the amount of flood which they produce down below as the Bengal Government had done in 1917 when they appointed Mr Glass to work out all these details for the Damodar Valley It is well known that but for the basic work of Mr Glass it is not probable that any multiple scheme could have been worked out by Mr Voorduin, late of the T V.A and now in the employment of the Central Technical Power Board

The precipitation in the Mahanadi catchment does not take place simultaneously, and to the same extent in all parts of the Mahanadi Valley The catchment area is about 400 miles long and a single storm never covers it entirely The different section of the area receive rain in different times and herein lies the possibility of devising measures for controlling the floods. The measures to be taken depend to some extent upon our ability to forecast the incidence of catastrophic rain storms in the sections of the upper catchment a few days ahead Let us quote, in this connection, two short paragraphs from Prof P C Mahalanobis' study of "Rainstorms and River Floods in Orissa".

"We may assume, further, that the locus of heavy rainfall moves with approximately the same velocity as the centre of the storm itself The sequence of events may now be described Heavy rain first falls in the delta; about 11 or 12 hours later in Mahanadi section I (*i e* , in the region adjoining the delta extending up to Sonepur), Brahmani section I (southern part of the catchment), and in the catchment of the Baitarani and other minor rivers, about 24 hours later in Mahanadi section II and III (the valleys of the Tel, Ib, Mand and Hasdo) and Brahmani section II and finally about 40 hours later in (rest of the catchment) Mahanadi section IV and V (*i e* , the valley of Jonk and upper Mahanadi) It will be noticed that this average duration of the storm within the area under consideration is only about 48 hours" (page 12, *Sankhya*, Vol 5).

"It takes some time for the flood water in the basin to reach Naraj The average velocity of flow is about 4 miles per hour or 6 feet per second except in section I where owing to the low gradient, velocity is about 2 2 miles per hour or 3 2 feet per second It usually takes about 44 hours for the flood water from section I to exert its greatest effect at Naraj; and 50 hours, 76 hours, 81 hours and 100 hours for the water from sections II, III, IV, and V respectively This lag between rainfall and flood makes it possible to issue flood forecasts sufficiently in advance of the actual occurrence of floods" (page 18, *ibid*)

We may go further than Prof. Mahalanobis has thought it possible to forecast the incidence. The rainstorms which cross Bengal and Orissa have their origin in well defined regions within the Bay of Bengal and lie 200 to 250 miles to the South-East They appear as gigantic cyclonic disturbances and it is now possible with modern technique not only to locate them but also to follow their track. If the Meteorological Department can instal a number of powerful Radar stations over the eastern coast and keep a constant watch it may be possible to give effect to these ideas Thus it appears possible to forecast nearly four days ahead and take precautionary measures for emptying the reservoirs in time so that they may be ready to catch up the whole amount of water which may be precipitated in any section of the valley and thus prevent floods in the delta region. This is of course only a general statement For its effective execution the whole catchment area must be properly surveyed and suitable dam sites discovered After the construction of this, the authorities will have to maintain a network of telegraphic communication between the different dams so that instructions from a central station may be quickly transmitted to each individual dam station and orders for either emptying a dam or filling it may be very quickly executed Unfortunately the survey work which must be the basis of all planning has not yet been done so that it is impossible to make a dependable plan for the water control system of the Mahanadi at this stage.

Navigation

Simultaneous with flood prevention, arrangements can be made to convert the Mahanadi into a navigable channel This is of particular importance for Orissa where topographic features provide insurmountable obstacles to land communication at reasonable cost. The river also flows through a country full of minerals and forests which cannot be exploited on account of lack of communications If the river be made navigable not only traffic in minerals and forest products are likely to develop on a scale which we cannot foresee now, but boat traffic for recreational purposes is likely to develop also.

Power Generation

We have mentioned previously that the Mahanadi, the Brahmani and the Baitarani dissipate about 70,000 KwH of energy. It is only a guess, and how much of it can be usefully harnessed, as primary energy, and how much as secondary energy and how much can be usefully utilized depends on a number of surveys mentioned above. But even a glance over the details of the main river and its trubutaries shows that possibly a large fraction can be harnessed. (Also see Fig. 11).

FIG. 12 The almost flat flood-plains in the upper valley (Chhattisgarh) and the delta lower down are rich agricultural regions and most densely inhabited. The plateau is largely covered with forests (deciduous) and contains most of the valuable minerals The dam-sites that have been shown are those suggested by various committees

SEARCH FOR DAM-SITES

A hurried search for location of storage sites in the tributaries for prevention of flood was carried out in 1862. This investigation is of some interest in that it has demonstrated that there exists at least one dam site in each of the important tributaries The details of this survey were later on revised by Mr J. Shaw in 1939 as reported in the Orissa Flood Advisory Committee (1930). Here are some details —

TABLE 1.

Rivers	Length in miles	Catchment (Approx) 6 sq miles.	Height of the source in feet	Height at which their mouths are situated.	Drop in height from source to mouth
Mahanadi	550	51,000	1,100	0	1,100
Left bank tributaries·					
Seonath	220	11,000	1,050	760	290
Kharan	77		1,000	900	100
Hasdo	172	14,000	1,700	700	1,000
Kelo	60		1,100	500	600
Mand	124		2,075	600	1,475
Ib	144		3,200	500	2,700
Right bank tributaries					
Pairi Sondhal	96	small	2,100	940	1,160
Jonk	99	2,000	2,100	750	1,350
Tel	163	12,000	2,250	400	1,850
		39,000			

Revised by J. Shaw, Ex-Eng., Floods & Drainage Div in 1939 (O F. A. C 1939).

Rivers. Site and situation of Dam	Catchment area (sq. miles)	Area submerged at full reservoir level (sq miles).	Capacity reservoir in million acre ft	Length of dams in ft	Height from lowest river level.
Tributaries·					
1. Karang, 15 miles north of Bilashpur.	196	14 7	0 156	1,320	60
2. Tel, Gantapara, 29 miles up stream of Sonepur	7,760	50	1 15	3,000	113
				2,000	60
				1,224	50
3. Ib, Rampur, 30 miles up stream	3,267	54	0 26	1,200	14
				1,254	42
				858	71
				2,178	94 6
				1,716	22
4 Mand, Deyjari, 30 miles up stream	1,854	45 5	0 23	7,120	65
5. Hasdo, Kandygat, 59 miles up stream	3,001	17·67	0 13	800	100
				750	12
6. Jonk, Maharaji, 16 miles up stream.	1,333	29 33	0 98	1,542	93
Total	17,215	196 5	2 8*		

* The amount of storage is only 2 8/88 i e., 3% of the total runoff. This is an extremely low figure when it is remembered that in the Tennessee Valley, the reservoir capacity is 22, 129, 320 acre ft i e., 50 per cent of the total runoff.

HIRAKUD DAM PROJECT

On March 15, 1946, the Governor of Orissa, Sir Hawthorn Lewis, K.C.I.E., I.C.S., laid the foundation of a dam at Hirakud 9 miles above Sambalpore in the presence of a distinguished gathering which included Rai Bahadur A. N. Khosla, Chairman of the Central Waterways and Irrigation Commission, Government of India We quote from the pamphlet which has been published on this occasion.

A PICTURE OF THE WHOLE SCHEME

"The Mahanadi Valley Project, as at present envisaged comprise the construction of three dams on the Mahanadi river with provision for power

generation and of three canal systems taking off at these dams for purposes of irrigation. The first dam will be at Hirakud 9 miles above Sambalpore. The second dam will be located at Tikkerapara some 130 miles down-stream and the third near Naraj about 10 miles upstream of Cuttack.

The lake formed by the Naraj dam will extend to the Tikkerapara dam and the lake formed by the Tikkerapara dam will extend to Sonepore about 60 miles below Hirakud The project will provide for navigation facilities from the head of the lake formed by the Hirakud dam right down to the sea—a distance of over 300 miles—by providing locks at the three dams and negotiating the fall between Hirakud dam and Sonepore by means of one or two weirs fitted with navigation locks.

Out of these 60 to 90 million acre feet of annual flow, it is proposed to impound roughly one-sixth or just over 10 million acre feet each year. It is proposed to construct the three dams at Hirakud, Tikkerapara and Naraj for a gross storage of 20 million acre feet. This storage will be divided into three parts. The one at the bottom of the reservoir, the "dead storage" will never be depleted and will account for 5 million acre feet and provide a silt reserve which will trap almost the entire coarse silt of the Mahanadi for a period of over one hundred years without causing any diminution in the usable or live storage at these reservoirs. This provision of silt reserve will meet one of the major objections against storage dams as a solution of the Orissa problem, namely that their life will be very limited due to silting of the reservoirs. Of the remaining 15 million acre feet, 10 million will be available for use in perennial irrigation and power development and the balance of 5 million at top as flood reserve"

The Shape of Things to Come

"In this way it will be possible to trap all harmful sands at the reservoirs, afford complete flood protection to the delta areas in Orissa, extend perennial irrigation to cover 2⅜ million acres both in Orissa and the adjoining States; generate cheap hydro-electric power possibly 200,000 K.W.; provide navigation facilities from the sea to the head of Sambalpur reservoir and to create extensive lakes for fish culture and recreational use. With cheap hydro-electric power it will be possible to exploit the great mineral wealth of Orissa and the neighbouring States, pump out water from waterlogged areas for their reclamation and for extension of irrigation and otherwise to extend the amenities of life to the urban and rural areas. The project will include adequate provision for the effective control and eradication of malaria. With this scheme fully developed, poverty and disease should be a thing of the past and Orissa and its neighbouring States, now among the most backward, will emerge wealthy and prosperous and stand as the equal of the more prosperous Provinces and States of India The subsequent control and development of the two other major rivers, the Burabalang and the Subarna-rekha would add further to the prosperity of Orissa and its neighbouring States.

Hirakud Dam Project—the most Attractive.

"Having presented the picture of the Mahanadi Valley development as a whole, I now proceed to deal in particular with the Hirakud Dam Project, the uppermost of the three component units Fortunately each one of the three units is capable of independent and stage development without getting out of joint with or impairing the integrated development of the Mahanadi Valley as a whole. Of these three the Hirakud Dam project is the most attractive as well as free from engineering and political complications It is likely to yield the earliest results.

The dam and reservoir area are situated exclusively within the territory of the Orissa Province. The area to be irrigated on either bank lies in Orissa in the head reach but extends further south in the Eastern States so that the latter can join in at any stage.

Further there is ample water in the river. Out of an annual runoff of nearly 40 million acre feet at Hirakud, only about 1½ million acre feet will be stored for purposes of irrigation and power development. Thus no question of water rights will be involved.

A preliminary geological investigation shows that the foundation rock at Hirakud is composed of granite gneiss, quartzites and phyllites which constitute suitable foundations for high dams.

The Hirakud site is the most accessible by rail as well as by road so that there should be no difficulty about transport of materials.

Limestone is reported to be available in the neighbourhood. If investigations prove it to be of good quality and in sufficient quantity it will be a good case for setting up a cement factory at the place to supply cement for the construction of the dams on the Mahanadi, their appurtenant works and works on the three canal systems. This if possible will effect large savings on the project as cement is one of the most expensive items of expenditure in dam construction. This cement factory will be a permanent asset to the Province of Orissa and the adjoining areas.

In the post-war scheme of development it is proposed to extend the Jharsuguda-Sambalpur railway

across the Mahanadi to link with the Cuttack-Madras and the Vizianagram-Raipur railways It is also proposed to construct a national highway through Sambalpur over a combined road and Railway bridge The construction of the Hirakud dam may have an important bearing on the final location of the combined road and railway bridge. Similarly the layout of the proposed Sambalpur. Sonepur Khurda road will be determined by the extent of the storage reservoirs at Tikkerapara and Naraj

From a consideration of the above factors and other technical details it will be obvious that the Hirakud dam must be taken up for construction first

The Hirakud dam will be about 100 feet above rock bed with a reservoir level of 610 feet above mean sea level. The area submerged by the reservoir will cover 130 sq. miles but out of this with the depletion of the reservoir a great proportion will be available for raising one crop during the year The dam will impound four million acre feet of water of which one million acre feet will form the dead storage for silt reserve and to afford head for power generation, 1½ million acre feet will be the live or usuable storage for use in irrigation and power development and 1½ million acre feet will form the flood reserve to absorb flood peaks It will be possible to have an installed capacity of 50,000 K.W of hydro-electric power at the dam, assuming a 50 per cent load factor The canal system will provide perennial irrigation to nearly 800,000 acres in the district of Sambalpur and in Sonepur and other Eastern States

The Hirakud dam project will by itself solve a fair proportion of the flood problems of Orissa and will form the first stage in the ultimate development of the Mahanadi Valley. The power development at the site linked to the Machkund power development will improve the financial and other prospects of the latter so far as Orissa and the adjoining States are concerned and will provide enough power for this area for many years to come On the financial side it is premature to make a definite statement but on a preliminary estimate the Hirakud dam project should be self-supporting.

In respect of surveys and investigations the present position is that the aerial survey of the Hirakud dam site and reservoir area has been completed. The ground control for the aerial survey is in progress. The contour survey of the area to be irrigated will be taken up shortly by the Survey of India Department both in Sambalpur district and with their permission in the States A preliminary geological investigation has been done. The detailed investigation with pits, drill holes, drifts and tunnels will be shortly undertaken as soon as the exploratory equipment becomes available.

Preliminary designs and estimates of cost will be taken in hand shortly. The programme of construction will be planned after the results of the preliminary investigations and studies become available.

After the detailed plans are ready it will be advisable to proceed with the construction of canals simultaneously with the dam and if necessary somewhat in advance so that irrigation can start as soon as the dam is built up to some height. The Project may take about five years to construct."

CRITICAL REVIEW OF THE HIRAKUD DAM PROJECT

Like the Tennessee the Mahanadi is served by a number of large tributaries and control and harnessing of the main river appears to be impossible without corresponding and adequate measure for the tributaries. This point appears to have been completely ignored in the Hirakud dam project. Several very weighty criticisms have also been directed against the Hirakud scheme by Rajasevasakta M. C. Rangiya*, sometime Chief Engineer and Secretary P. W. D, Bangalore and by Mr T. P. Misra, A I.S.M., F G.M.S, Geologist and mine-owner Sambalpur, Orissa. The latter objects to the hasty manner in which the whole plan has been drawn up without caring for and sufficiently investigating the minerals that are likely to be submerged in the project immediately in the dam site and complications that would be created in the mines elsewhere by percolation of water through faults The objections raised by Rajasevasakta are the following —

1. That a most fertile and populous area of the district will be submerged According to Mr Khosla's speech 71,000 acres of cultivated area and 93 villages will be submerged Part of this area consists of rice producing tracts, yielding annually one million maunds of rice valued at Rs 90 lakhs now and Rs. 30 lakhs in pre-war days and Rs 10 lakhs worth of other crops.
2. That rich mineral deposits of coal, limestone silver and lead and even diamonds will be lost by submersion.
3. That Sambalpur, a surplus district exporting about 5 to 10 lakhs of maunds of rice will become a deficit area in the future necessitating their importing rice from outside.
4. They also point out that the Government of Orissa are not in a position to utilise their share of the hydel power from the Dodt Ralls Project under construction and have leased 2/5ths of their share for 99 years to the Madras Government The Government are also said to be thinking of leasing the

* Mr Rangiya was in charge of construction of the Krishnarajasagar Dam, Mysore and a member of the Flood Advisory Committee of Orissa in 1939.

balance of 3/5ths (10,000 K.W.) to outside capitalists They therefore argue that there is no need for generating 50,000 K.W. at the Hirakud Dam.

5 They fear that as they themselves are not in a position to use the power the production and supply of large quantity of additional power may lead ultimately to the installation of textile and rice mills by outside capitalists thus destroying the occupation of the local weavers and villagers

6 They do not agree that 800,000 acres can be cultivated by the proposed reservoir and state that the country is unsuitable for such concentrated irrigation

7. The admittedly partial protection afforded against floods is at best of a precarious nature the life of the dam being limited to 100 years

8. That it is cruel and heartless to deprive the people of their staple foodgrain drive and make them rear fish in the reservoir and use it instead of rice

Though we do not agree completely with the objections raised by Messrs Misra and Rangiya it is difficult to escape the conclusion that the Government project has been drawn up rather hastily.*

APPENDIX 1

Name of State	Area in sq miles	Population Total No of souls	Density per Sq miles	Revenue in Rupees	Resources
Athgarh	168	55,508	330 40	1,25,601	
Athmallick	730	72,755	99 45	2,41,461	Minerals —Kaolin, Graphite
Bamra	1,088	1,78,348	89 80	6,45,815	
Baramba	142	52,924	372 60	1,00,741	Minerals —Mica
				1,12,379 (as given at present)	Forest —Timber, Bamboo, Kend Leaves
Bastar	13,725	6,33,888	46 20	14,68,121	Minerals —Corundum, Iron (very large quantities), Manganese, Soapstones, Lithium, Mica (very large quantities) Forest —Timber, Sal Sleepers of all size—large quantity, Lac, 800 mds per annum
Baudh	1,264	1,46,175	115 65	4,64,490	Minerals :—Manganese—roughly over 10,000 tons Average below 44 p c Mn , Mica, Iron Ore, White Earth, Lime Stone Forest :—Bamboo (abundantly available), Timber (abundantly available), Hides
Bonai	1,296	92,573		1,98,313	Minerals :—Copper (Pyrites)—available in isolated quantity no prospecting done—Red and Yellow Ochres, Mica—small quantity—Iron - potential production estimated 648,000,000 tons. Manganese 1,000,000 tons reserve, Bauxite—isolated deposits
Changbhakar	906	21,127	23 25	67,441	
Chhuikhadan	153	32,715	207 18	1,16,717	
Daspalla	563	53,833	95 75	1,41,993	
Dhenkanal	1,463	3,24,212	221 55	5,78,556	Minerals :- Mica
Gangpur	2,492	3,99,297	160 27	8,21,962	Minerals :—Iron (fairly large quantity), Manganese (fairly large quantity), Mica (fairly large quantity), Red and Yellow Ochre (fairly large quantity)
Hindol ...	312	58,505	185 45	1,60,481	
Joshpur	1,923	2,23,632	116 30	4,01,405	
Kalahandi	3,745	5,99,751	130 52	6,43,422	Minerals :—Graphite, Manganese, Mica
Kanker	1,430	1,49,471	104 50	1,49,471	Minerals :—Iron, Lime Stone, Ochre, Mica, White and yellow earth. Forest :—Teak, Sal, Bija timber, Bamboo, Hassa Kend leaves
Kawardha	805	77,253	96 00	2,68,350	Minerals :—Red and Yellow Ochres, Iron, White clay, Mica Forest —Teak, Sal Bamboos—80 00,000 may be available annually, Myrobolam—200 tons, Hides—100 tons (annually), Lac
Koenjhar	3,217	5,29,786	164 75	11,91,901	Minerals :—Chrome, Iron Ore—potential production—988,000,000 tons, Kaolin, Manganese Ore—10,00,000 tons Leather —Hides, Bones, Horns Forest :—Timber, Sabai grass, Lac, Myrobolam, Tassar Agriculture :—Rice, Pulses, Oil, Seeds

APPENDIX 1—(*Contd.*).

Name of State.	Area in sq. miles	Population Total No. of souls	Density per Sq miles	Revenue in Rupees	Resources
Khairagarh	931	1,73,839	184 45	5,53,104	Forest :—Timber, Teak, Sal—large quantity, Charcoal, Firewood, Bamboos (large quantity), Grass, Leather, Hides, Horns.
Khandpara	240	87,341	364 00	1,76,501	
Kharswan	127	50,305	396 00	1,50,936	Minerals :—Copper, Kaolin, Red and Yellow Ochres, Kyanite—good deposits
Koera	1,647	1,26,974	77 12	9,74,974	Minerals :—Iron, Coal—1,120,120 annually produced Forest :—Crude lac 5,000 mds produced annually.
Mayurbhanj	4,243	9,90,977	233 48	34,16.491	Minerals :—Asbestos—annual production 50 tons, Kaolin—production 100 tons, Kyanite—annual production 20,000 tons, Copper, Red and Yellow Ochre—production 50 tons, Mica, Iron Ore—production 40,000 tons Tatas are raising 3,000 tons per day, Manganese, Friable Quartzite Forest :—Silk, Tassar (Timber), Hard woods, soft woods, Bamboos, Shellac, Seerlac, Sabai grass (cotton) Textiles existing annual production 4190 yds Cotton Textile production 32,947 yds. Tassar production 6822 yds
Nandgaon	871	2,02,916	232 90	4,86,939	Minerals —Bauxite, Feldspar, Cotton—Cloth, potential production 7,30,000 yds P M, Bandages, production 2,50,000 Mosquito Netting, production 2,07,000, Timber, lac, production 2,000 mds. Agriculture :—Rice, Arhar, gram, etc
Narsingpur	207	48,448	234·00	1,29,888	Forest —Bamboos, supplies made at present to Titaghur Paper Factory, Kend leaves.
Nayagarh	1,552	1,61,409	104 00	4,47,642	
Nilgiri	284	73,109	257 55	2,14,589	Minerals :—Asbestos, Iron
Pallahara	450	34,130	75 85	95,500	
Patna	2,511	6,32,220	251 75	11,02,251	Minerals :—Potential production annually, Graphite 1,000 to 15,000, carbon content 50% to 90%—Kaolin, Mica, Manganese 3,000 tons, Manganese content 38% to 43%. Plastic clay 500—1,000 tons Rock crystal 100—200 tons (in Mds) Agriculture :—Paddy 4,00,000; Jute 35,000; Hemp 10,000; Tobacco 25,000; Mustard 30,000; Til 50,000; Linseed 15,000; Ground Nut 600; Lac 200; Sabai Grass 50,000
Raigarh	1,486	3,12,643	210 25	5,39,457	Minerals —Coal 3,900 tons annually, Dolomites, Iron 1,110 tons, Lime-stone, White clay Forest :—Bamboo and Wooden articles, Lac 4,000 mds annually, Shellac 300 mds annually Miscellaneous —7 rice mills at present producing 400,000 to 500,000 mds. and Jute Mill (Gunny bags) producing 2,000 tons
Rairakhol	833	38,185	45 90	1,17,828	
Ranpur	204	51,301	241 40	1,05,825	
Sakti	130	54,420	418 40	1,17,753	Minerals :- Iron, Lime Stone and Dolomite—29,000 tons annually
Sarangarh	540	1,42,065	263 00	2,46,284	
Seraikella	449	1,56,374	348 30	4,03,473	Minerals :—Asbestos—existing production 300 tons a year Potential production 1,200 tons a year. Kyanite—existing production 3,000 tons a year, potential production 6,000 tons Kaolin, Copper—the Copper belt passes through the State. Chrome—potential production 3,000 tons a year. Red and Yellow Ochre, Mica, Iron, Steatite—existing production Rs. 7,000 only, potential production Rs. 20,000 only. Phospate Feldspar—potential production 1,000 tons a year. Galena and Iron Pyrites.

APPENDIX I—(*Contd.*).

Name of State.	Area in sq. miles	Population Total No of souls	Density per Sq miles	Revenue in Rupees	Resources
Sonepur	961	2,48,878	259 00		
Surguja ..	6,035	5,51,307	99 30	7,28,838	Minerals —Mica, Coal, Bauxite, Iron Ore, Lead Ore, Sulphur, Lime Stone, Ochres Forest :—Sal trees.
Talcher ..	399	86,432	216 55	3,40,226	Minerals - Coal, Red and Yellow Ochres, Mica, Iron, Graphite and Manganese
Tigiria .	46	26,331	572 40	53,684	
Udaypur .	1,045	1,18,325	113 15	2,56,043	

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GEOLOGICAL FACTORS IN THE INTERPRETATION OF INDIAN GRAVITY DATA

P EVANS and W CROMPTON

(*Continued from last issue*)

RESULTS OBTAINED IN INDIA AND BURMA

Although there were some 6,000 gravity stations within the region dealt with, most of these were for detailed surveys within the alluvial tracts and we were concerned with only a few hundred stations Where these are on or at the edge of the hills, geological knowledge is sufficiently good to enable the effects of the light sediments to be calculated, but in the central parts of large alluvial tracts the estimations were necessarily rough.

Maps —The starting point of the work was the plotting on the map of the discrepancy between the observed gravity and the calculated gravity This made it possible to define areas of excess gravity and areas of deficient gravity. These are best shown by 'contours' of equal gravity anomaly, often termed isogams, and in figure 17 are shown the B anomalies in Bengal, Assam, and Burma with an isogam interval of 25 milligals. The system of isogams is very intricate but there is clearly some relation to the structural lines depicted in figure 6. The anomalies range from plus 50 to minus 250 milligals

If the B anomalies of figure 17 were to be corrected for the hypothetical compensating masses of the Pratt-Hayford-Bowie hypothesis, the resulting map should be greatly simplified , in fact, if the

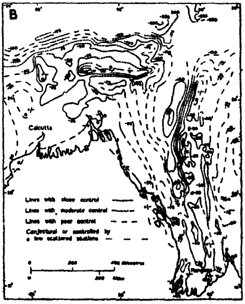

FIG. 17. B anomalies of North-Eastern India and Burma.

hypothesis is true, the anomalies should all but disappear. The 'compensation' has been calculated and the correction applied, the result being shown in figure 18 Evidently the anomalies have not disappeared, their range has been reduced from 300 milligals to 220 milligals, but it is clear enough that the Hayford correction does not succeed in getting rid of more than a small part of the discrepancies It is indeed obvious that although India is the home of the hypothesis of isostasy, the Indian evidence does not (as Brigadier Glennie and others have already pointed out) lend support to the view that the earth's crust is almost in isostatic equilibrium. Admittedly there are extensive areas where the anomaly is less than 25 milligals, but this is a very considerable amount, and a larger scale map would show that the areas in which the anomaly is small, say 10 milligals or less, are narrow irregular strips forming only a small proportion of the whole

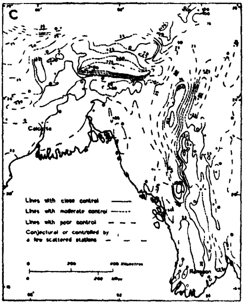

FIG. 18. C anomalies of North-Eastern India and Burma.

Our contention is that neither of these maps provides a satisfactory picture of the true gravity anomaly produced by unknown irregularities in the sub-crust, and that to obtain such a picture we must remove the gravity effects of the known and inferred geological structures. First of all the correction for the local light sediments has to be computed in some such way as we have described. This may conveniently be termed making the correction for known geology. The corrections we calculated are shown in a generalized form in figure 19. There is so much variation from point to point as one passes from the crest of an upfold to the adjacent trough that generalization is unavoidable. The effects of the thick sedimentary development south of the Shillong

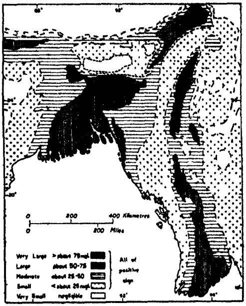

FIG 19 Generalized map of geological corrections for North-Eastern India and Burma.

Plateau are very well shown, so too are those of the sediments of the Chindwin, the oilfields region, and the Burma Delta

The géological correction was applied station by station to the B anomaly, and in this way we obtained what may be called the anomaly after geological correction There is an alternative term, residual anomaly, implying that it is the residue of the anomaly after making allowance for the various corrections, but this term is also used in a rather different sense So it seems convenient to refer to the anomaly after geological correction as the G anomaly. The G anomaly, then, is the discrepancy which still remains between calculated and observed gravity after allowance has been made for the height of the station, for the material between the station and sea-level, and for the difference between the actual density of the formations near the station and the assumed standard density of 2 67. This anomaly, we claim, gives the best picture of the actual discrepancies which remain to be explained by hypotheses concerned with the state of the deeper parts of the earth's crust.

Figure 20 shows the gravity map after application of these corrections, that is, the map of the G anomaly. Comparison of figure 17 and 20 shows that the picture is greatly simplified; amongst the detailed changes may be pointed out an area in Southern Burma where what was a gravity low turns

out to be a gravity high. The great change is the appearance of a comparatively simple system of gravity highs and lows bearing a close relation to the main geological lines of figure 6 We have a clear set of north-south lines in the greater part of the area and lines with a Himalayan trend in the north—a few exceptions will be referred to below. Here then we have a map of gravity variations which shows only those irregularities which are due to unknown causes deep down in the earth's crust. On the west there is evidently light material in the sub-crust; in the centre, heavy material; then a pronounced line of light material beneath the frontier ranges, followed by more heavy material beneath the Irrawaddy Valley and again light material in the extreme east The big feature of low gravity in the hills between Assam and Burma coincides closely with a major uplift, whilst the gravity maximum of the Irrawaddy Valley agrees with the volcanic line In the north there is a steady fall in gravity as one approaches the Himalayan ranges

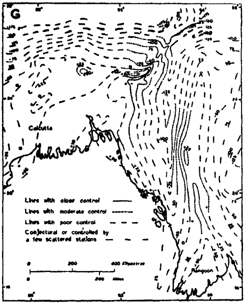

FIG 20 G anomalies of North-Eastern India and Burma

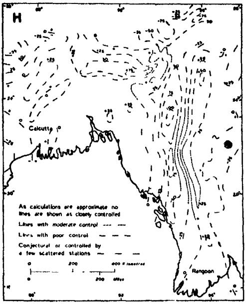

FIG 21 H anomalies of North-Eastern India and Burma

One further reference to isostasy is necessary. It would be possible to apply to the G anomalies a correction for the hypothetical 'compensation'. This should allow not only for the supposed compensation of topographical irregularities, but also for compensation of density differences in the material composing the surface. If this is done, a geologically corrected isostatic anomaly is produced—which we have termed the H anomaly. In general, the map does not differ greatly from the G anomaly map although the bold and simple features are less evident. If the region were in isostatic equilibrium, the anomaly should nowhere exceed a few milligals; a detailed map would show that there are only a few small scattered areas with an anomaly less than 10 milligals, whilst there are (as figure 21 shows) many areas with an anomaly of over 50 milligals, and the total anomaly ranges from almost +100 near Haflong to −100 in the Chindwin This can by no stretch of imagination be said to fit in with the supposition that the region is in isostatic equilibrium Here we have conclusive proof that for a large part of India the hypothesis of isostasy is not applicable.

Profiles.—An alternative way of presenting the results is to choose suitable lines crossing the 'grain'

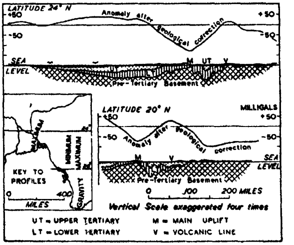

FIG. 22 Profiles of geologically corrected (or G) anomaly.

of the country and to draw graphs of the gravity variations along these lines These graphs (termed 'gravity profiles') are most conveniently drawn above a geological cross-section, and this enables us to see at once the connection between geological structure and gravity anomaly Two representative profiles are shown in figure 22, and from these we see clearly the correspondence of the main uplift (M) with the gravity low and of the volcanic line (V) with the gravity high

Causes of Anomalies—We may now ask what causes these broad regional gravity features If we know the breadth of the anomaly and its amplitude, it is possible to get a fair idea of the nature of the mass which causes it In figure 23 are two equal masses of different shape, and we see the different gravity curves produced It is well known that there is no unique solution of a gravity picture, but at least we can set limits to what is possible, and there is little doubt that the explanation of the big gravity anomalies of India and Burma is to be sought in the constitution of the crust at great depths

these layers which would give the necessary residual anomalies have been worked out for the profile along latitude 24°, and are shown in figure 25. In one diagram the intermediate layer is squeezed out

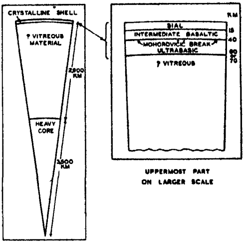

FIG 24 Diagrammatic representation of crustal shells

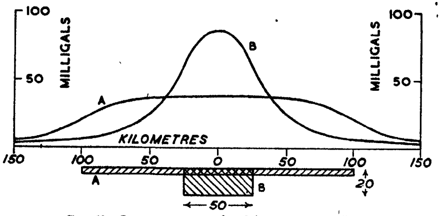

FIG 23 Gravity curves produced by masses of different shape

Seismological work has shown that beneath the ordinary surface rocks familiar to geologists there are a number of layers or zones distinguished by different elastic properties, and the crust is often represented by three layers or shells:—sedimentary and granitic, basic, ultrabasic. Figure 24 showing these crustal shells is admittedly an unduly simplified picture but it is convenient for our present purpose as there is no certainty yet about details The upper sedimentary and granitic layer normally extends down to about 15 kilometres, the intermediate basic layer to about 40 kilometres ; but there is very much variation, the upper layer (or shell) being absent beneath the Pacific and very thick beneath some mountains. Two representations of modifications in laterally, the top of the ultrabasic layer being only slightly modified, whilst in the other the thickness of the intermediate layer is not greatly altered, but the top and bottom are both depressed.

Another example is provided by the gravity profile near Darjeeling. This again indicates one way in which the data can be explained. It is merely as an illustration of the sort of thing that must be postulated Whatever distribution of light and heavy matter is imagined, it is essential to have an appreciable amount of light matter extending well south of the edge of the hills—far out into the Ganges Plain. Despite all that has been written, the observed defects of gravity cannot be accounted for solely by assuming vast thicknesses of light alluvium

and of Tertiary rocks in the region south of the Himalayas.

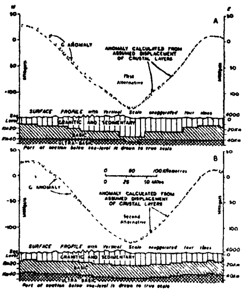

FIG 25. Gravity profile of G anomaly along latitude 24°

Now if we turn back to the map (fig 20) we shall see that the arrangement of gravity features indicates a tendency for negative anomalies to occur in narrow belts with the positive anomalies in broad

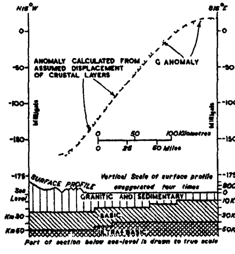

FIG. 26. Gravity profile of G anomaly near Darjeeling

fields. This agrees with Vening Meinesz's observations in the Netherlands East Indies, but the large negative anomaly in the Shan States seems to be an exception, for it probably links up with negative anomalies found in Indo-China and Yunnan.

Next we may compare the India and Burma results with those from the Netherlands East Indies The most striking feature of figure 27 is that the gravity high along the Burma volcanic line finds its counterpart in Vening Meinesz's gravity high along the volcanic line of Sumatra and Java, and it seems likely that the gravity minimum of the Arakan Yoma corresponds to the gravity minimum of Babi and Nias and Timor This neat fitting-in to the well-known submarine work seems of considerable importance and suggests that a detailed check across the gap in the Bay of Bengal should be undertaken by a submarine expedition In parenthesis we should add that although the anomalies found in India and Burma do not give their simple pattern until they have been corrected to allow for the effects of local geology, the Netherlands East Indies results show such large gravity maxima and minima that their positions could not be greatly altered by making the correction for local geology

Deltas It will be noticed that each of the four deltas included in the map forming figure 27 shows relatively high gravity The Indus Delta is similar, and it may be added that the Nile Delta is another area of excess gravitational attraction.

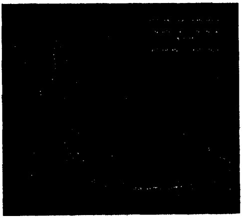

FIG 27 Principal gravity anomalies in North-Eastern India, Burma, and the Netherlands East Indies.

Local Anomalies This discussion has necessarily been concerned with the broad features of the gravity field, but one of the smaller features seems worth brief mention. A narrow belt of relatively high gravity runs through Haflong in a general north-easterly direction. Figure 28 shows that the isogams of the G anomaly have a V-shaped course with the apex pointing north-east. The shape of the isogams is influenced not only by some local disturbance but also by the Himalayan gravity field and the north-south gravity field of Burma and southern Assam An analysis to eliminate these fields as far as possible did not affect the anomaly, which remained as a distinct local high.

The sharp gradient of gravity—that is the close spacing of isogams—shows that the anomaly is a local one due to some relatively shallow cause. The

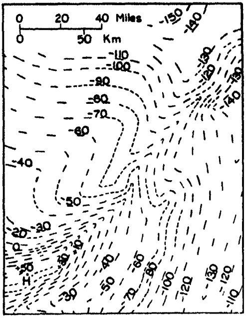

FIG. 28 G anomaly near Haflong

anomaly follows exactly the course of the Belt of Schuppen (or region of overthrusting) shown on figure 6, and it seems possible that contemporaneously with the faulting there were intrusions of basic or ultrabasic rocks which did not succeed in penetrating to the surface. The profile and section of figure 29 give an idea of the anomaly and of the kind of igneous intrusions which could produce it

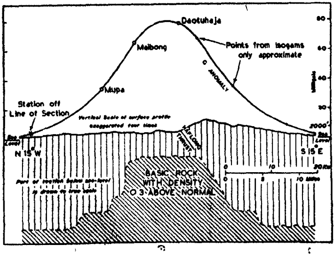

FIG. 29. Gravity profile near Haflong.

CONCLUSIONS

This survey of the main points discussed in the paper in the *Q J Geol. Soc.* may be rounded off by a summary of the general conclusions suggested by our work. In the first place, we have shown that before the full significance of gravity data can be properly appreciated, it is necessary to allow for the effects of density variations in rocks near the surface. Our own investigations have been confined to North-East India and Burma, but in the north-western part of India sediments attain a great thickness and geological corrections of +50 milligals or more are applicable to many stations. In Peninsular India, on the other hand, corrections will be smaller and in some instances negative, the rocks having more than average density (fig. 30) There are many other

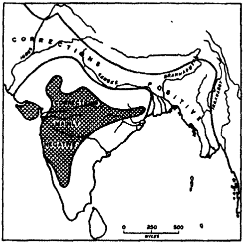

FIG 30 Gravity corrections in different parts of India

parts of the world (for instance California) where the sediments are sufficiently thick to make large geological corrections necessary. In such regions it is only after the geological corrections have been applied that the relationship between the gravity anomalies and fundamental geological trends may be expected to become fully apparent.

Next is the demonstration that no matter what corrections are applied we cannot get the data to support the Hayford conception of isostasy, and it seems rather pointless to make elaborate calculations to find the isostatic anomaly.

Still more pointless are the discussions about the precise depth at which 'compensation' is complete. Bowie made immensely detailed investigations to see whether 113·7 kilometres is a better depth than 96 kilometres. Quite apart from the weakness of the fundamental hypothesis, these calculations have ignored the effects of surface geology ; we regard

them as completely useless, and comparable to such ancient speculations as those about the number of angels that can dance on a pin.

In the past there has been a tendency to judge the success of a particular brand of isostatic correction by the extent to which it removes anomalies, this presupposes that the crust is in isostatic equilibrium, which is not true for such areas as the Netherlands East Indies and a great part of India and Burma. We suggest that this criterion should be used with great caution, and that the suitability of a correction is best judged independently of the amount of the anomaly that it leaves

The choice between the different anomalies, and the best way of calculating, say, the B anomaly is a subject which is perhaps hardly one for detailed discussion here, but in our paper we do emphasize how important it is that records of surveys should give at least the B anomaly which includes the fewest assumptions.

We believe that consideration of the geological correction should *precede* any discussion of the effects which originate from greater depths, whether this discussion is concerned with isostasy or seismology or anything else. Our feeling is that much of the muddle in the past has come from a faulty order of treatment—people have jumped from the B anomaly to the isostatic anomaly and only *afterwards* have they groped half-heartedly backwards towards the geology. We are here repeating the plea, still little heeded, made by David White over twenty years ago

Another conclusion which seems important is that there is a need for a synthesis of the seismological evidence and the gravity evidence In a few areas seismologists have been able to demonstrate the thickening of either the upper granitic and sedimentary layer or the middle basic layer, the Indian gravity evidence points to thickening of one or other of the layers, and it is desirable to obtain both seismological evidence and gravity evidence from the same region. In the Eastern Alpine region the seismological evidence suggests that the uppermost layer has a variation from 15 to 40 kilometres within a distance of 150 miles, the intermediate layer apparently maintaining a nearly constant thickness. In the Sierra Nevada region in California on the other hand the upper layer maintains a constant thickness and the intermediate layer varies from 20 to 45 kilometres in thickness within a distance of about 50 miles These variations are as great as those postulated to account for the Indian gravity evidence

It is unfortunate that in North-East India and Burma there is no network of seismic recording stations, despite the frequency of earthquake shocks The establishment of a few up-to-date stations for obtaining seismological data in Bengal, Assam, and Burma would undoubtedly yield results of fundamental importance in the study of the constitution of the earth's crust, and it may be hoped that advantage will some day be taken of what is an almost unique opportunity for research, and that seismological data will be obtained and correlated with the gravity data

Finally we do particularly stress the importance of co-operation between geologist, geophysicist, geodesist, and seismologist, and we believe that in such a co-operation the geologist should play an essential part. In allowing the mathematicians to abduct the hypothesis of isostasy and turn it into a relatively unprofitable path, geologists may have been at fault, and we should beware lest the same fate befall other conceptions in that realm of science which today we term geophysics. There is a very wide field of inquiry in which geologists, geodesists, geophysicists, and seismologists can profitably go into partnership, and no fear of incompatibility of temperament between the partners should be allowed to stand in the way of co-operation.

HOW JUTE WORKERS LIVE

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and
H. K. CHATURVEDI

IN September 1944, a request was received by one of the authors of this note (Prof K P Chattopadhyay) from an organized body of labour welfare workers that report on the economic condition of the jute workers on the basis of exact facts would be helpful The Indian Statistical Institute was approached by him for funds and also for technical help in sampling The area selected was Jagatdal and its neighbourhood as the Statistical Institute had earlier, in 1940-41 and 1941-42, carried out economic surveys in this area. The total number of workers in the jute mills in this locality was about 40,000 in 1940-41 and the number had not changed appreciably in 1944-45 when the present survey was carried out A sample of nearly 700 units was selected on each of these occasions The units surveyed in the earlier period were included in the recent examination for observation of changes But only 450 such units could be traced An additional 305 units were studied in their place The surveys were carried out in about the same season on both occasions

Five surveyors were engaged and they worked (actually eight including replacements) under the supervision, in the field, of H K Chaturvedi The surveyors as well as the field supervisor took up their quarters in a big hut in the *bustee* where a large colony of jute workers resided As the employment of a cook and servant promptly led to their being doubted as agents of jute mill owners and hampered free and easy study of living conditions of the workers, the surveyors dismissed the servants and took turns at cooking of their meals A visit was also paid by K. P. Chattopadhyay to the labour area and the purpose of the survey carefully explained to disarm suspicion and enable friendly contacts to be made

Design of the Survey.—The entire area under the jurisdiction of Jagatdal Police Station was divided into five contiguous blocks, on the basis of density of the labour population and connected factors. All the labour families were also enumerated and locations obtained with the help of the cadastral survey maps. The design for sampling was based on the 5×5 Latin Square arrangement, the columns representing the blocks, the rows the five surveyors, and the letters representing the five time intervals, in which the survey was carried out Sample families chosen from each block (randomly) were randomly apportioned between the five investigators and the survey was carried out in such a manner that no two investigators worked together in the same block in any time interval. The field work commenced in the first week of December, 1944 and was completed in the first week of March, 1945. As noted earlier, in all 755 schedules were filled up Simultaneously with the collection of family budgets and the data on living conditions, the price of commodities used by the workers were collected from the most frequented shops and markets. This was done to estimate the cost of living index of the Jagatdal area

Units Surveyed.—The units surveyed were of two types:

(*a*) the family consisting of related persons such as parents, children and others who live in the same hut or residence and have a common kitchen for meals and meet the expenses from a common pool,

(*b*) individuals, who have not brought their families with them. A fair proportion of jute mill workers belong to this category They normally send a portion of their earnings to their people at home. In the units, a person under 16 years of age has been described as a "child" in conformity to the definition given in the Factory Act

In the sample studied 488 units were families with a total of 2,010 individuals, with an average of 4·42 members The remaining 300 units were individuals. Of the total population studied 34·1 per cent were adult men, 28 3 per cent adult women, 20 8 per cent male children and 16 8 per cent female children.

The total wages as well as other income of the two types of units and also their expenses per month are noted below in rupees.

	Average wage for unit	Other income	Total expense	Deficit
Individual ..	25·00	10 61	36 55	0·94
Family .	37·80	23·80	64·60	3·00

It may be noted in this connection that the figures for income and expenditure obtained in the earlier survey (not quoted in this note) show that the total income has increased by 69 8 per cent and 109 4 per cent for individual and family units respectively The corresponding figures for expenditure show an increase of 75 9 per cent and 87·1 per cent Formerly the "individual" had a slight surplus whereas the family had a large deficit of about Rs. 5/2/- per month It would appear, therefore, that wages have not risen in proportion to expenses for individual workmen In a family there are earners as well as dependants. As the war and associated activities brought in a demand for a large number of labourers (and war industries sprang up in the Jagatdal area), the family income was increased to a greater extent than for the individual unit Nevertheless, the total income lagged behind the total expenses due to increase in prices of food and other necessities In all 62 7 per cent of the family budgets studied were found to show deficit

Food.—The first essential for life is food, and for health it is necessary that the diet should be balanced and nutritive An examination of the actual quantities of various articles of food consumed by the jute mill workers reveals a serious deficiency in this respect. The details will be noted, first, for individual workers The average consumption per month for an individual was found to be 17 02 seers of cereals (rice, *atta* etc), 4 37 seers of potato and onions, 4 32 seers of other vegetables, 4 66 seers of pulses, 1·57 seers of fats and oils, 2 57 seers of milk, meat and fish, *i.e* , animal proteins and 1 17 seers of salt and spices The total comes to 35 68 seers per month, *i.e* , 1 27 seers per day Taking one seer as equal to 32 ounces approximately, this comes to 40·6 ozs daily According to Dr W R Aykroyd (*vide* his note on Results of Diet Surveys in India, published in 1941), an adult workman should have a balanced diet of 43 ozs daily The proportion of nutritive food is also much lower in the diet of our jute worker Thus the adult workman is expected to take per month (30 days) 14 seers of cereals, 9 4 seers of vegetables of all kinds, 2 8 seers of pulses, nearly 2 seers of fruit, an equal amount of fats and oils, and 10 3 seers of milk, meat, fish and eggs It is clear that actually he gets about 8 per cent less of vegetables, no fruit, about 20 to 25 per cent less of fats and oils, and 75 per cent less of animal protein than he needs These deficiencies he tries to make up by taking more cereals and pulse If we exclude salt and spices and compare only the articles of food as noted by Aykroyd, we find that the deficiency in quantity is about 9 per cent.

In the case of the family units, the position is worse. For comparison with the individual units, it is necessary to calculate from the total food consumed per family the average taken per adult. In the families there were on an average 2·51 adults of whom one was a man. If we assume one adolescent and 0 91 younger children and take the consumption of food as three-fourths of an adult male for a woman and two-thirds that of an adult male for an adolescent and of the other children as half only, we may obtain a fair estimate of the consumption per adult. It may be added that these values give a much higher average (about 15 per cent) than what would be obtained if Lusk's tables for conversion of family consumption into equivalent adult units were used. They are, therefore, not under-estimates The figures are given in ounces per day per capita —

	Cereal	Vegetables	Pulse	Fruit	Fats & Oils	Meat, milk etc	Total
Aykroyd's recommendation	15	10	3	2	2	11	43
Adult takes in sample family	18 7	6 3	3 5	Nil	1 1	2 0	31 6

Evidently, the deficiency in total quantity is of the order of 25 per cent while animal protein is lacking to the extent of 80 per cent, and vegetables and fats and oils are barely half of what are needed The earlier survey had also revealed deficiency in diet for the individual as well as the family But there has been a sharp decline in even the poor diet that was available in 1940-41 The reason is very simple A reference to the prices for 1940-41 and 1944-45 for the same period reveals that rice has gone up in price by 273 per cent and *atta* by 187 per cent (rationed prices for both) Pulses, potato, fish and meat, which are not rationed show an increase of prices by 360, 533, 290 and 343 per cent respectively Milk is no cheaper, having gone up 300 per cent in price The effect of this abnormal all round rise in prices and the failure to supply rationed cereals at least at a cheap rate increased the per capita expenses in 1944-45 on food by 92·1 and 87 3 per cent respectively for individuals and families over the 1940-41 level The individual who used to spend each month on food Rs 8·12 in 1940-41, spent in 1944-45 Rs. 15·60 for this purpose. In the family, however, the resources per capita were much smaller. We find that in 1940-41 the food expense per capita was Rs. 4 66 but it rose to Rs 8·73 in 1944-45 Even allowing for the presence of children and adolescents in the family, the lower values indicate the poorer quality of the food, which we have already stated in detail. It may be noted here that if cereals and pulses had been supplied at cheap rates or if the

dearness allowance or basic wages had risen proportionately, at least the total quantity of food consumed per capita would not have fallen below the required amount. We may add in this connection that the fuel prices needed for cooking has also gone up to over 300 per cent (coal to 377 per cent and firewood to 329 per cent) and the expenses per capita have doubled for this item.

Clothing.—After food, we may consider the expenditure on clothes. In 1940-41 the individual worker used to purchase 36.7 yards of clothes per annum besides 2.9 yards of miscellaneous clothing. In 1944-45 these amounts fell to 26.9 and 2 yards respectively, *i.e.*, decreased by 27 per cent. In the family, the earlier period shows a total purchase per capita of 18.4 yards and in 1944-45, of only 12.7 yards which is a reduction by 31 per cent. While the total quantity purchased thus fell sharply, the expenses per capita rose for individuals from Rs. 16.6 to Rs. 30 per annum and for families from Rs. 6.6 to Rs. 13.6 in 1944-45. The expense on clothing has actually increased by 80.7 and 106.1 per cent respectively for individuals and families. A detailed examination revealed that inspite of such increase, purchases of coats, caps, wrappers etc. for winter and of articles of bedding have practically disappeared. Only the clothing needed to cover the body, like ***dhoti, saree, lungee***, shirts etc. and the simple ***gamcha*** (thin towel) for washing were bought by the workmen. Here again a reference to the price tables for the same season in 1940-41 and 1944-45 furnishes adequate explanation. *Dhotis, sarees*, and shirtings have gone up in price by 278, 267 and 278 per cent and *lungis* and *gamchas* by 421 and 367 per cent. The purchase of the essential articles of clothing left no surplus for the articles of bedding or for winter clothes.

Housing. We may now pass on to the question of living. This has never been hygienic or satisfactory. In his evidence before the Royal Commission on Labour in India in 1929, the Assistant Director of Public Health, Government of Bengal, stated about the residence of workers in industry that "the size of rooms vary from 8′ × 8′ to 10′ × 10′. In nearly all cases the rooms are provided with verandahs 4′ wide used for cooking purposes. The rooms are dark and in none of them sunlight can penetrate through. Regarding ventilation, it is unsatisfactory". Usually three workers occupied such a hut. In 1943, K. P. Chattopadhyay visited a number of huts selected at random in one of the biggest jute workers' *bustees* in Howrah. None of the huts inspected were better than those described in the report quoted above, even after a lapse of fifteen years. On the contrary, they had no verandahs for cooking. It was done in the room unless the men arranged for messing elsewhere. The floor space per capita in 1928 was 28 square feet or thereabouts, excluding the verandah. This was also found to be the case in 1940-41 and 1943. The floor space per capita was 28.6 square feet showing that there had been no improvement. In 1944-45 the average floor space was found to have dwindled to 24 square feet per head. This is an area 6′ × 4′, equivalent to that of a *charpoy* on which workmen sleep. In other words, the jute workers live in huts, huddled side by side without any room to stretch or move.

Owing partly to the fact that in many jute mills the employers furnish quarters (of this type), the rental has risen only ten per cent. In Calcutta and certain areas, rent control has also been effective. But the quality of sanitary arrangements has fallen considerably. In some of the Jagatdal jute mill barracks, the employers had actually given permission to 7 men to live in rooms which previously could house only 4 persons. As no arrangement was made for increased conveniences, men and women were found in these areas to get up at about half past four in the morning and to queue up to be able to finish their ablutions etc. to be in time for the morning shift at the mill. Regarding the type of floor and roof of these residences it may be noted that 67 per cent had tiled roofs, of which 42.6 per cent were of country made ***khola***, and about 5 per cent were covered with thatch or tin plate. The remaining 28 per cent were ***pukka*** terraces. Brick floors were found in 42.3 per cent rooms and another 11.7 per cent had these cemented. The other 46 per cent huts had only mud floors. Nearly 82 per cent rooms had brick walls and the rest were of mud.

Comforts. It is often stated loosely that workmen waste a good deal of their earnings on drink, smoke and dissipation. A careful study was, therefore, made of the expenses on various heads like those on betel, tobacco, intoxicants and amusements. The per capita expenses on betel and tobacco was, for an individual, a little less than half anna daily or Re. 0.89 per month in 1940-41. When prices soared more than 200 per cent upwards, in 1944 the expenses barely doubled on these heads. They rose to Re. 1.95 per head. For families, the per capita charges were much less, being Re. 0.22 and Re. 0.57 per month for the two periods. The expense per capita on intoxicants was about 6 annas per month for individuals in 1940-41, and rose to 8 annas in 1944-45. For families the corresponding figures were 2 annas and 3 annas respectively. It may be added that the price of tobacco went up by 800 per cent and country liquor by 162.5 per cent during the interval.

The amount spent on amusements was 2 annas per head per month for individuals in both periods. As prices of cinema tickets and also tickets for all

kinds of shows increased during 1941-45, this means that the visits became less frequent For families the per capita expenses on amusements were half anna and one anna per month in the two periods. The visits to cinemas and other places of entertainment were obviously very rare at both periods Considering the hours of work of the mill hands, the poor food they get, the bad houses they live in, and the practical impossibility of having normal recreations in social or community life, it must be admitted that they spend precious little on their so called vices—smoking, use of intoxicants or visits to places of amusement.

A study was also made of the expenses on education, postage, newspapers and medical treatment and ceremonials Some rites cannot be avoided, these are attendant on birth, marriage, and death Some religious ceremonies are equally important in the lives of Hindus as well as Muslims The expenses per capita per month on education, postage and news papers was about 3 annas for individuals and 1 anna for families in both periods. For medical treatment, it varied from 4 to 5 annas for individuals and from 3 to 5 annas for family members Ceremonials were more expensive, but even these came to a total of 11 annas per capita per month in 1940-41 and rose to Rs 1 1 in 1944-45 per individuals For families the figure was 5 annas in both periods Another important item has to be mentioned in this connection—that on services rendered by the washerman and barber The total expenses on these heads

	Individual		Family	
	1940-41	1944-45	1940-41	1944-45
Food	8 12	15 60	4 66	8 74
Clothing	1 28	2 31	0 51	1 05
Fuel & Light	0 80	2 59	0 41	1 19
House Rent	0 61	0 61	0 34	0 39
Comforts	4 44	6 76	1 45	2 26
TOTAL	15 25	27 87	7 37	13 62

came to 7 annas per capita per month in 1940-41 and rose to 9 annas in 1944-45 for an individual. For families the corresponding figures were 2 annas and 3 annas respectively.

In the table the average per capita expenses (in Rs) for individuals and families are given in summary form under the major heads A small amount is also sent each month to village homes. This is not included in calculating the percentages set out in the next paragraph

It is obvious from these figures that the "individual" spent 58 5 per cent and the "family" 68 8 per cent of its total disbursements on food and fuel in 1940-41 and that these figures rose to 65 3 and 72 8 per cent respectively in 1944-45 Clothing and house rent took another 12 4 and 11 5 per cent of expenses in 1940-41 for the two units, these figures actually decreased a little, to about 10 5 to 10 6 per cent for the two groups to make room for expenses on food. What we have termed "comforts" through courtesy are largely necessities They accounted for 29 1 and 19 7 per cent of expenses for the individual and the family in 1940-41 In the period 1944-45, the percentages fell to 24 2 and 16 6 respectively. This again was done to meet the increasing cost of essential food commodities We have shown in our detailed discussion on food, clothing, habitation etc. how the quality and quantity of each has deteriorated. A calculation of the cost of living index for 1944-45, on the basis of 1940-41 figures, gives the value 273. As the total increase in income has been 69 8 per cent for individuals and 109 4 per cent for families, the deficiency has been met by reducing the already low standard of living

During the period of the survey and immediately prior to it, the jute mills made enormous profits and also paid large sums as Excess Profits Tax. A small portion of these profits if spent on increasing the basic wages and dearness allowance of jute workers, and in improving their quarters could easily have made this drastic reduction of a poor standard of living unnecessary

Notes and News

ATOMIC ENERGY IN GREAT BRITAIN

The passage of the Atomic Energy Bill by the House of Commons in October 1946 has gravely threatened the freedom of research and scientific enquiry in Great Britain This Bill empowers the representatives of the Ministry of Supply to enter and search premises without a magistrate's warrant The jurisdiction of the Bill is so vague, vast and elastic that the activities of any laboratory devoted to almost any branch of fundamental science may be examined and scrutinized and its free progress severely interfered with at the bidding of the Ministry The Bill has taken particular care of the publication and dissemination of scientific information on 'atomic energy' and 'plant' and has deliberately chosen to be vague and wide about the interpretation of 'atomic energy' and 'plant' in order to be able to include for action almost all scientific discussions and publications As a specific instance, free discussion or publication of results of researches in new developments of cyclotron parts that may be achieved has been forbidden The cyclotron is not only an important appliance in atomic energy investigations, it has also become an indispensable instrument for research in certain branches of biological sciences Imposition of restriction of this character would not only strangle healthy advance in fundamental physical sciences, but would seriously affect research progress in such humanitarian sciences as biophysics

According to another provision contained in what has been described by many in Great Britain as the infamous clause 11, it is made an offence to communicate knowingly, without the consent of the Minister, any information on equipment, devices or processes used or proposed to be used for the release of atomic energy This includes even small scale production of radio active elements Since scientists in Government employment, entrusted with work relating to atomic energy, are sworn to secrecy, the clause can only apply to workers in University laboratories and similar private research institutions It is apprehended that this clause would tend to prevent free discussion between collaborators in the fields of physics, engineering, chemistry, and such other subjects as border on atomic energy As almost any new developments in these sciences may result at a later date in some useful application bearing on atomic energy, workers in such fields will naturally tend to be secretive and uncommunicative for their own safety The inevitable result of all this would be that research workers would prefer to work in isolation and in water tight compartments very much like the scientific investigators in the medieval times of religious persecution

We have had the privilege to study the reaction of the introduction of the Atomic Energy Bill in the scientific periodicals and publications that we receive from Great Britain Most of the papers have doubted the wisdom of various provisions and clauses and, on the whole, commented adversely on the Bill It does not appear that the Bill is the outcome of free democratic discussion and that it represents the will of the scientific workers and of all concerned in Great Britain The following comment of *The Chemical Age* is worthy of note

> The Government claimed that the reactions of many people and organizations were received But as the Bill in its final form differs little from that originally proposed it would seem that either the reactions were favourable or if unfavourable they were ignored by the Government The first hypothesis is untenable since some aspects of the Bill were criticised by more than half the speakers in the debate while further criticism came from associations of scientists outside the House It would thus seem that expert opinion unfavourable to the Bill has been ignored by the Government '

Not long ago, Sir Henry Dale, then President of the Royal Society, in a letter to the *Times*, made the following remark

> We have tolerated much and would tolerate anything to ensure the victory for freedom but when the victory has been won we shall want the freedom I believe further that the abandonment of any national claim to secrecy about scientific discoveries must be a prerequisite for any kind of international control such as will obviously be indispensable if we are to use atomic energy to its full value and avoid the final disaster which its misuses might bring If it be objected that this would be incompatible with military secrecy of any kind I should be bold enough to ask whether that is not already useless If armaments are to be used only for the international policing of aggressors what use have we for national secrecy? And have we not on the other hand had sufficient experience of the futility and the danger of facts and agreements which impose quantitative limits on known and obsolescent types of armament and leave the right to qualitative improvements and new developments in secret? '

Sir Henry Hale made a further point in these words

> "It (military secrecy) is bound, if we tolerate it, thus steadily to widen its encroachment and strengthen its hold on the freedom of science Soon, under such conditions, many of the scientists of some country at peace would find themselves in secret competition with those of another, as ours were ready to be with those of Germany in war, as to

which could earlier elaborate the means of annihilating the others, and their countrymen and country with them

Great Britain and, in fact, most of the countries in the world today are determined, from an exaggerated fear of atomic bomb, to strangle this freedom of research and scientific enquiry which mankind has established during the last three hundred years as an indispensable condition of human progress and prosperity

NATIONAL INSTITUTE OF SCIENCES OF INDIA

"The role of science in the building of New India" was the subject of the presidential address delivered by Mr D N Wadia, at the 13th Annual General Meeting of the National Institute of Sciences of India, held at Delhi on January 1, last

Speaking on the role of science and research in India in the transition period, Mr Wadia stressed the importance of developing the basic sources of untapped wealth, *e g* land, man power, rivers, forests minerals and electric power He referred briefly to the work of the Royal Society Empire Scientific Conference held last year and informed that a symposium would be organized by the National Institute in April next for devising ways and means of implementing such recommendations of the Conference as have direct bearing on India's economic and scientific development

He said,

"India today is a country with a great potential This position has been attained by a process of natural evolution from her great historic past and is not wholly the result of sub recent history of the last few generations or of the impact of the two World Wars as is often imagined Much more powerful factors have been operating since the Aryan migrants occupied the Indo Gangetic plains The rich heritage of three millennia's experience has moulded the course of events during this long eventful history and it would be wrong to attribute to purely local or modern or accidental causes her emergence into a nation that has won its present status and forged the bridges and affinities with the neighbouring continents

India's attitude towards science in the past has been luke warm, hesitating and even patronizing and the result of this is becoming manifest in the country's population outstripping its productive capacity in agriculture and industry instead of these variables functioning exactly the reverse way—increased productivity of field and factory inducing and sustaining an increased population The signs, however of a welcome departure from this indifference towards science are becoming visible in the last few years as our leading men of science are multiplying ties with representative scientific workers of England America Russia and the rest of Europe "

Concluding, Mr Wadia referred to the rapidly declining asset of our mineral resources and discussed the problem of ensuring their maximum utilization for the benefit of the nation India had so far no definite mineral policy , absence of any such policy and plan of development of mineral resources led the country's mining industry largely controlled by foreign interests to develop and organize, for ready profit, wholesale export trade in raw ores and minerals which could have been worked and developed in this country to the best interest of the people India's resources in minerals like iron ore, mica, beryl, manganese, titanium, thorium, aluminium and magnesium metals are of considerable magnitude and of world importance "The relatively large thorium content in monazite (8 to 9 per cent TiO_2) and its small but usable uranium component (0 3 to 0 4 per cent U_3O_8) give to the monazite reserves of the Travancore coast, estimated at over 2 5 million tons, a strategic and economic value which must be utilized with greatest circumspection on a planned scheme of long range development for the good of the country and of the world at large " A policy of conservation and progressive development is urgently called for and it is highly reassuring that the Government of India is taking steps to bring under Federal control a number of minerals of all India strategic importance to the extent to which the regulation and development is declared under Federal Law to be expedient in the public interest

The following were elected to the Council of N I S for 1947 *President* Sir S S Bhatnagar , *Vice Presidents* Profs S N Bose and H J Bhabha, *Honorary Secretaries* Prof D S Kothari and Dr H S Pruthi , *Foreign Secretary* Dr J N Mukherjee , *Editor of Publications* Rai Bahadur Dr S L Hora

MINERAL WEALTH OF INDIA

LACK of trained "Mining Personnel" in relation to mineral development was the main theme of the speech delivered by the Hon'ble Mr C H Bhabha, Member for Works, Mines and Power, Government of India, at the Forty First Annual General Meeting of the Mining, Geological & Metallurgical Institute of India, held on January 17, last at Calcutta

To remove this deficiency in our mining personnel, Mr Bhabha indicated immediate action in two directions (1) the fullest utilization of our existing supplies of man power and (2) rapid increase in the outturn of our universities and technical institutions

The Government has already initiated measures to remove the obstacles in these directions, but Government efforts must be supplemented by mining industrialists and scientific bodies The problem of practical training could be solved only by the co-operation and assistance of mining and metallurgical firms He suggested that the Institute might appoint a committee to consider the problem in consultation with experts and trade associations If even a frac

tion of the recommendations of the two conferences on mineral policy, recently held at Delhi, were to be carried out, Government departments, Central and Provincial and industrialists would require a large cadre of mining and metallurgical technicians

In conclusion, Mr Bhabha said, ' You can rest assured that the present Government attaches the greatest importance to mining and metallurgical development and will spare no pains to do their best to remove the present bottleneck in this development arising out of our acute shortage of technical man-power of all grades "

In his presidential address, Dr H Crookshank referred to his visits to the Indian States and reviewed the mineral resources in them with particular reference to coal, mica, beryl, emerald, tinstone, monazite, columbite tantalite, cerussite, triplite and corundum

Referring to the manufacture of cement in this country, Dr Crookshank was of opinion that if the Government desired to control the selection of sites to spread the industry evenly in economic units, all likely areas should be carefully examined and sampled

The following were elected to the Council of the Institute for 1947 *President* Mr J K Dholakia, *Vice-Presidents* Mr N G Chatterjee, Mr M N Goon, and Dr W D West, *Treasurer* Dr L R Gee, *Secretary* Dr A K Dey, *Editor of Transactions* Dr P K Ghosh

NATIONAL PHYSICAL LABORATORY

The foundation stone of the National Physical Laboratory, on which we already commented in a leading article (*Science and Culture*, June, 1946) was laid by Pandit Jawaharlal Nehru, on Saturday the 4th January last, in the presence of a large gathering of distinguished men of science at New Delhi

Stressing the importance of starting atomic energy research in India, Pandit Nehru said, "Presently we may have to follow other countries in having a great atomic energy research institute also, not to make bombs, I hope, but, nevertheless, I do not see how we can lag behind in this very important matter, because atomic energy is going to play a vast and dominating part, I suppose, in the future shape of things Already it is known that radio-active elements that are produced can be used for therapeutic purposes, but in regard to other matters, too, it will make power mobile and this mobility of power can make industry develop anywhere. We will not be tied up so much by the accidents of geography " The mobility which atomic energy would possess would be of use to small scale cottage industries as well, said Pandit Nehru

He hoped that the National Physical Laboratory, which would soon begin functioning would be followed by numerous other research institutes and laboratories and a stream of earnest young men and women would go through it and come out to serve the country and the world There was too much talk of money or the lack of it but when nations were bent on carrying on war, there was no question of lack of money It was only for constructive schemes that money was lacking Lack of money must not stand in the way of the development of India

Pandit Nehru further emphasized the necessity to make the masses understand what the scientists were doing He suggested that leaflets should be printed in Hindi and Hindusthani and distributed among villagers, explaining how such laboratories would affect their lives

In inviting Pandit Nehru for laying the foundation stone, Sir Shanti Swarup Bhatnagar briefly described the organization and function of the N P L of India The laboratory's foremost function will be the maintenance of fundamental and derived standards, and the undertaking of research with a view to achieving greater and greater accuracy in the measurement of those standards The work of the laboratory will be carried on through the following nine divisions (1) Weights and Measures, (2) Applied Mechanics and Materials, (3) Heat and Power, (4) Optics, (5) Electricity, (6) Electronics and Sound, (7) Building and Housing Research, (8) Hydraulic Research, and (9) Analytical Chemistry

"These laboratories do not intend to supplant but to supplement the work of individual or collective industrial concerns in respect of research They undertake work of the kind that does not come ordinarily under the scope of industries Since they are able to command resources wider than the industries can, the laboratories can employ more talent and try alternative approaches to problems simultaneously Problems which bear wider social aspects than an industry could be concerned will become subjects of State scientific research Moreover, the advice that State research can give will be non-partisan Industry can hardly undertake work of a purely exploratory nature So the function of these laboratories is both complementary and independent "

Concluding, Sir Shanti Swarup said, "These are days of decision for India and if she is to take, as she must, her rightful and honoured place among the nations of the world she must grow strong and great industrially In this great and exacting venture the role of the national laboratories will be vital and

the people of our country, whose mind and face are already turned towards science in industry and society, will, I am sure, take great interest in the work of the laboratories and extend their unflagging help in their development"

ROCKET BORNE SPECTROGRAPH TO EXPLORE THE SUN

The recent use of V 2 rockets in obtaining high altitude photographs of solar spectrum, to which Dr Shapley referred in his lecture on galaxies at the Delhi session of the Indian Science Congress opens out a new field of astro physical research In October, 1946, the U S Naval Test Unit and Army Ordnance Departments jointly undertook to shoot spectrograph in the air and obtain automatic photographs at various altitudes up to 65 miles above the surface of the earth The spectograph and the camera were mounted on a V 2 rocket and fired at the Army's White Sands Proving Grounds in New Mexico The automatic mechanism provided in the arrangement enabled the spectrograph to operate continuously and record spectrum at various altitudes About 40 of these spectrograms are now under investigation at the Naval Research Laboratory in Washington The appearance of many new lines whose intensities are being calculated and other related data analyzed has been reported

The importance of the study of high altitude photographs of solar spectrum lies in the fact that such photographs are likely to reveal many new lines normally absorbed by the ozone in the earth's atmosphere and, therefore, many new facts about the physics of the sun In the past the study of solar spectrum has led to the discovery of new elements like helium and useful understanding of the constitution of the sun So far the solar spectrum has been limited to 2900 Å on account of absorption by ozone of the atmosphere The photograph now taken above the ozone layer has extended solar spectrum to 2100 Å Further extension of the spectrum below this limit was not possible owing probably to the use of quartz spectrograph We understand that, in future rocket experiments, fluorite and vacuum spectrographs will be used when it is expected to obtain solar spectrum right up to about 400 Å In that case it will be possible to photograph the fundamental Lyman lines and the lines between 1216 to 900 Å of hydrogen as well as the helium lines up to 500 A In his lecture, Dr Shapley mentioned that the idea of sending spectrograph high up in the air was first suggested by Prof M N Saha, during his visit to the Harvard College Observatory in 1936 It has now been rendered possible by the development of V 2 rockets by the Germans It is needless to mention that the extension of the solar spectrum to the ultra violet region is the most important observational work in solar physics, for many years Detailed study of the shorter wave length region of solar spectrum which can now be easily photographed by means of rocket borne spectrograph, is expected to considerably extend our knowledge of the sun

EXPANSION OF PLANT SYSTEMATICS

THE Systematics Association held a meeting at the Herbarium, Royal Botanic Gardens, Kew on October, 5 last Welcoming the members Sir Edward Salisbury, Director of the Gardens, briefly outlined the long service of Kew to plant taxonomy and the intimate co operation between the various departments with the common aim of advancing research in the many problems of plant classification

The history of the progress of Taxonomic Botany from 370 B C to 1946 A D was illustrated by a collection of books and manuscripts paintings and drawings and other exhibits

The large families viz orchids and the grasses served to illustrate the difficulties of classification due to incomplete correlation in different categories of characters Problems of relationship' were further demonstrated by the occurrence of similar characters in groups widely scattered in well known systems of classification, e g, symplocaceae Rosaceae and Theaceae Anonaceae and Aristolochiaceae, Ochnaceae and Primulaceae and Magnoliales Hamamelidales Aceraceae Platanaceae and Lauraceae respectively show some characters in common

Similar difficulties also occur in the Cryptogams The genus *Psalliota* (mushrooms proper) consists of species or 'microspecies' extremely difficult to separate one from another by any definite, and constant characters In the smuts so called 'physiological races occur which are morphologically indistinguishable but are limited to different hosts, while conversely, on the same host morphologically distinct kinds may occur Hybridization frequently complicates the work of taxonomists

In modern taxonomy, full and carefully prepared descriptions and sometimes with statistical methods are demanded Unfortunately the combination of taxonomist and biometrician is rare and few statistical methods have been devised for the special use of the taxonomist The attention of biometricians is drawn to this fact The genus *Ulmus* (elms) have been recently investigated based on statistical methods

Correlation of morphological characters with anatomical structures in taxonomic work is also emphasized A new book prepared at Kew, on the

anatomy of Dicotyledons will stimulate interest in the subject

The need for experiments, with taxonomic aims in view, on living plants is now fully realized and facilities for work in this direction, is being developed at Kew

Taxonomy has to serve all branches of biology—hence its basic importance In applied botany for example, for many years there was much confusion over the numerous cultivated species and varieties *e g*, *sorghum* A standard monograph on the subject, at Kew has been invaluable to economic botanists

The Systematists Association is now on a firmer foundation and all biologists interested in the problem of classification and evolution may join the Association. Particulars can be obtained from Dr R Melville, Royal Botanic Gardens, Kew (England)

NOBEL PRIZE IN PHYSICS AND CHEMISTRY

THE Nobel Prize in Physics for 1946 has been awarded to Prof P W Bridgman, of Harvard University, for his production of extremely high pressures and his discovery of many new facts about the behaviour of materials under high pressure

Half of the Nobel Prize in Chemistry for 1946 has been awarded to Prof J B Sumner, of Cornell University, who isolated the first enzyme in 1926, for his distinguished research in the field of enzymology. The second half is jointly awarded to Drs J. H. Northrop and W M Stanley, of the Rockefeller Institute, Princeton Dr Northrop is also an authority on enzymes Dr Stanley specialized in virus researches In 1935, he isolated the virus of tobacco mosaic, using a salting-out technique which had previously been employed to concentrate enzymes He obtained the virus in the crystalline form and proved it to be a nucleoprotein containing phosphorus This remarkable discovery of a substance which, on one hand, has the properties of living matter, *e g*, self multiplication, and, on the other, properties of any ordinary inert chemical substance provided a link between inorganic and living matter

INDIAN CHEMICAL SOCIETY

THE 23rd Annual General Meeting of the Indian Chemical Society was held on January 3, 1947 at the venue of the Indian Science Congress at Delhi, under the chairmanship of Dr J N. Mukherjee, the President who addressed the meeting on the chemists' rôle for the promotion of chemical science, research and industries The following were elected to the Council of the Indian Chemical Society for 1947 *President*—Prof. P. Rây, *Vice-Presidents*—Prof. B. C. Guha, Dr P C Mitter, Dr K. Venkataraman; *Hony. Secretary*—Dr B. N. Ghosh; *Hony Treasurer*—Dr K N Bagchi, *Members of the Board of Editorial Correspondents*—Dr B. Ahmad, Dr P. K. Bose, Dr B C Guha, Dr J. N Ray; *Ordinary Members of the Council*—Mr G C Mitter and Dr Mata Prasad (Bombay); Dr D. Chakravarti (Calcutta), Dr P. C Guha (S I)

LADY TATA MEMORIAL TRUST

Scientific Research Scholarships, 1947-48.

THE Trustees of the Lady Tata Memorial Trust are offering Six Scientific Research Scholarships of Rs 250/- each per month for the year 1947-48 commencing from 1st July, 1947 Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognized University The scholarships are tenable in India only and the holders must undertake to work whole-time under the direction of the head of a recognized research Institute or laboratory The subject of scientific investigation must have a bearing either directly or indirectly on the alleviation of human suffering from disease Applications must reach by March 15, 1947 Further particulars can be had from the Secretary of the Trust, Bombay House, Bruce Street, Fort, Bombay.

ASSOCIATION OF SCIENTIFIC WORKERS IN INDIA

THE readers of "Science and Culture" are aware of the lead taken by Prof M N Saha in organizing an Association of Scientific Workers in India Early in December, an Organizing Committee, with Professor Saha as the Chairman, was set up to draft the constitution of the Association of Scientific Workers of India, and it was decided to formally inaugurate the establishment of the Association during the Science Congress week at Delhi

At Delhi, as a result of mutual discussion among large number of scientists, it was felt that such an Association covering the whole of India should be started by the members of the Science Congress who represent the widest cross-section of scientific workers available in this country. It was also proposed that a fresh Provisional Committee be formed. Accordingly, a Provisional Committee was formed with Pandit Jawaharlal Nehru as President, Dr B. C. Guha and Dr B Ahmad as General Secretaries, and the following members *Assam, Bengal, Bihar and Orissa*—Prof M. N Saha, Dr N Mukerji, Dr B. Banerjee; *Punjab and N W F. P.*—Prof. M Afzal Hossain, Dr P. K. Kichlu, *Delhi and Sind*—Mr. C Mitra; *Bombay, Baroda and C. P.*—Prof H. J. Bhabha, Dr K. Venkataraman; *U. P.*—Prof. Sir K. S. Krishnan, Dr S. Gupta; *South India*—Sir J. C. Ghosh, Prof. M. Qureshi, Mr M. Sreenivasaya.

The Association of Scientific Workers of India was formally inaugurated by Pandit Jawaharlal Nehru in a General Meeting held on the 7th January, 1947. Prof. Blackett, President of the British Association of Scientific Workers and Dr Harlow Shapley of the American Association of Scientific Workers spoke on the occasion and conveyed greetings to the newly formed Association. Professor Saha, in his speech, described the deplorable condition of the Indian Scientific Workers and also traced the development of the growth of this movement in India Dr Guha referred to the work of the World Federation of Scientific Workers

We understand that Pandit Nehru has given the following message:

"I consider it a privilege to be associated with the Indian Association of Scientific Workers Such an Association was urgently needed in India and the Indian Science Congress has given shape to it at the right moment It is meant to protect these workers and to help them. It is meant also for the advancement of science and the service of the community I hope that scientific workers all over the country will join this Association and make it an active and vital organization."

The business meeting of the Association of Scientific workers of India, as arranged before was subsequently held at Delhi under the chairmanship of Prof M. N. Saha A resolution was adopted stating that until the period when the constitution of the Association of Scientific Workers of India inaugurated by Pandit Nehru is brought out the association which has already been formed will continue its activities (barring enrolment of fresh members) *e g*, collecting facts about the position of scientific work and Scientific Workers in India and give publicity to the same.

MALAVIYAJI MEMORIAL FUND

In response to an invitation issued under the joint names of Pandit Jawaharlal Nehru and Sir S Radhakrishnan, a meeting was held, with Hon'ble Pandit Jawaharlal Nehru in the chair, at the Constitution House at New Delhi at 2-30 P.M on Thursday, the 23rd January, 1947, for an informal consultation in regard to the raising of a Memorial to the late Pandit Malaviyaji.

The meeting adopted a resolution that a memorial fund should be settled on a Trust for the principal object of extending and developing the activities of the Benares Hindu University and also for such other objects as the committee may decide upon. Some members were, however, of opinion that the memorial should be established with the object of carrying on and helping the work of Pandit Malaviyaji in all directions, one of which should be the Benares Hindu University also.

It was decided to set up a Central Executive Committee with Sir S Radhakrishnan as the Secretary and with powers to co-opt. The following were elected members of the Committee

The Hon'ble Pandit Jawaharlal Nehru, the Hon'ble Sardar Vallabh Bhai Patel, the Hon'ble Dr Rajendra Prasad, the Hon'ble Pandit Govind Ballabh Pant, the Hon'ble Sir Purushottam Das Tandon, the Hon'ble Shri Rafi Ahmad Kidwai, Shrimati Sarojini Naidu, Shri K M. Munshi, Sir Alladi Krishnaswami Ayyar, the Hon'ble Maharajadhiraj Sir Kameshwar Singh of Darbhanga, Seth Ghanshyam Das Birla, Sir Shri Ram, Shri Goswami Ganesh Datt, Dr Shyama Prasad Mukerji, Babu Jyoti Bhusan Gupta, Sir S Radhakrishnan and Pandit Govind Malaviya

ANNOUNCEMENTS

The *Agharkar Commemoration Gold Medal* was awarded for the first time to Mr Jagadish Chandra Saha, M Sc, on the merits of his research work in Mycology and Plant Pathology, at the Annual General Meeting of the Indian Botanical Society held at Allahabad in December last. Mr Saha was until recently a lecturer in Botany at the Presidency College, Calcutta and is now one of the overseas scholars of the Government of India undergoing training in Plant Quarantine methods in U S.A.

The Committee of Management of the Indian Association for the Cultivation of Science has decided to award the *Bimala Churn Law Gold Medal* to Sir Robert Robinson, M A, D Sc, LL.D., the President of the Royal Society of Great Britain.

The *Jay Kissen Mookherjee Gold Medal* for 1945 of the Indian Association for the Cultivation of Science was declared to be awarded to Dr Harlow Shapley, Director of the Harvard Observatory in U.S A, on the 20th January, 1947, when Dr Shapley delivered a lecture at the Association Hall on 'Measurements of Galaxy'.

SCIENCE IN INDUSTRY

THE HOT-AIR TURBINE

THE recent progress and developments in the hot-air turbines have led many to think that, as prime movers, they are likely to prove in near future a very powerful rival of the popular steam turbines Preliminary experiments carried out to date all indicate that, in fuel consumption, hot-air turbines will definitely prove more economic than the steam turbines. In an interesting article in *Discovery* (September, 1946), Mr W O Horsnaill points out that the steam turbines which are now under construction in connection with the Severn Barrage Scheme of hydro-electric power production in England would involve a consumption of coal of about 0·99 lb. per h.p. per hour. The corresponding fuel consumption in hot-air turbines will be around 0·7 lb of coal Recent experiments on hot-air turbine at the Polytechnique school at Zurich show that at full power, with 31·5 per cent thermal efficiency, the fuel consumption is 0·58 lbs. of good coal or 0·435 lbs. of fuel oil per h.p per hour. For larger power installations, say of about 13,500 h p, at which a higher thermal efficiency to the extent of 46 per cent is realizable, the consumption may come down to as low a value as 0·4 lb. of coal or 0·3 lb of fuel oil per h.p per hour.

The hot-air turbines very closely resemble steam turbines in action The essential parts are a compressor, a heat exchanger, a combustion chamber and lastly the turbine itself The circulation of the air or gas and the various processes to which they

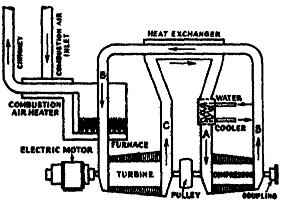

FIG. 1. Diagram showing the essential features of hot-air turbine (*Discovery*, Sept. 1946).

are subjected are clearly brought out in the diagram (Fig. 1) taken from Mr Horsnaill's article. At the time of entering the compressor through the pipe A, air has a pressure of about 6 atmospheres and temperature of 68°F On passing through the compressor, it attains a pressure of 24 atmospheres The rise in temperature is effected in two stages, first at the heat exchanger and finally in the combustion chamber itself In the heat exchanger, use is made of the still hot (about 700°F) exhaust gas from the turbine, which is allowed to move through the pipe C and circulate round the inner tube B In the combustion chamber furnace, air attains the final temperature of 1100°F. The furnace consists of two concentric cylinders, the inner one of which rises from the base, while the outer one is suspended from the top Four jets of boiler oil are burnt at the bottom of the combustion chamber At another small heat exchanger (not shown in the diagramme), the escaping hot gases are utilized in heating the air supplied for combustion The air, thus heated, emerges from the furnace and runs the turbine

The vastly expanded air, in fact, generates more power than is needed to operate the compressor, and this excess power is available for driving locomotives, propelling ships, running machineries and for such other useful work The whole operation is a cyclic and continuous process From the turbine the hot air, as mentioned, passes through the heat exchanger and then through the water cooler and finally enters the pipe A to be compressed again An electric motor or an oil engine initiates the whole sequence of operation. To obtain the highest efficiency, a high pressure and a low pressure turbine are needed

GRAIN SORGHUMS

DURING the war, the shortage of conventional materials and demand for substitutes for industrial purposes have brought into prominence many minerals and agricultural products which hitherto received very little attention. One such agricultural product was grain sorghums, a minor member of the cereal family. The grain sorghums are, however, different from the common sorghum or sorgo, a plant important for its sugary juice, and are also known under various other names, *e.g.*, *milo*, *kaffir*, and *durra*

Sorghums closely resemble the common more plentiful cereals such as wheat, corn, barley, etc They bear kernels largely composed of carbohydrates and proteins. Industrially the grain sorghums were not attractive until recently, owing to the fact that they grew at great heights and with considerable

irregularity of stem and kernel. This prevented the grains from being mechanically harvested and, therefore, grown on large scale. Recently a sorghum hybrid has been developed by the geneticists, and the problem of large scale mechanical harvesting has been satisfactorily solved. The grain sorghums can also be grown in semi-arid regions and show remarkable ability to thrive with little moisture.

The industrial use of grain sorghums followed the shortage of the common and more important varieties of grain such as wheat, corn, etc., when these came to be increasingly used by maltsters, brewers, distillers, wet millers and syrup manufacturers According to *Technological Review*, a waxy type of grain sorghum, developed and perfected during the war, supplied a replacement for tapioca. This was necessitated by the shortage of cassava root, the conventional raw material for tapioca. Grain sorghum has been found quite suitable for the purpose and is still being used in U.S.A. as the raw material for tapioca. Grain sorghums are further reported to have potential value as human food and, in certain parts of Africa, are actually consumed as such.

GERMANIUM—THE NEW INDUSTRIAL METAL

GERMANIUM has recently come to lime light as a new industrial metal. Its manifold industrial applications, for which the metal attained strategic importance during the war, include various alloys, film resistors, and radar parts As germanite, the metal is known to occur in South West Africa, and, as oxide, in Great Britain and Russia In the two latter countries the oxide is contained in the coal ash and flue dust to the extent of 1 per cent, which is expected to be economically workable. The commercial production of the metal has been a very recent undertaking and the various problems connected with large-scale production still remain to be solved. In an article in *The Chemical Age*, November 2, 1946, William Bull has described the recent research progress on germanium in the U.S.A. and has given an account of its various industrial uses which have led to the prominence of germanium.

Germanium is less refractory than silicon, and is intermediate between silicon and tin in alloying facility, while glasses containing the dioxide possess great refractivity, dispersion, and density, lower softening points, and greater viscosity than those with SiO_2. Demand for germanium arises from its applications to radar, from its exceptional properties as applied to design of film resistors and from the remarkable character of two notable alloys which expand slightly on cooling with consequent application to small-scale precision casting, *e.g.*, the use of the binary Au-Ge eutectic in dental inlay work. Now, thanks to the development of a method of production on a larger scale, it is likely that the industrial sphere of germanium will be progressively developed. A Societe Francaise Radio-Electrique patent of August, 1939, for example, relates to a cathode material, containing 74 per cent Al Ge, 2Fe, 3Ci, useful for electron tubes because of its strong secondary emission of electrons, while a U.S. patent of January, 1929, enters the sphere of germanium high-resistivity film deposit in Pyrex or dense ceramic tube resistors. Recently in this field of high-resistivity germanium films the Baytelle Institute has worked out a method by which the films, to gauged amount and even distribution along tube interiors, can be systematically duplicated

Germanium film resistors possess exceptionally high resistivity, measured over a 2 5 cm. length of 7 mm. Pyrex tubing. Resistances range from 1000 ohms upwards, according to deposition conditions, while temperature coefficients vary only from 0 001 to 0·003/1°C., and even lower temperature coefficients are obtained with silvered tubes. Germanium and silicon as semi-conductors have rectifying characteristics. The Cornelius germanium-crystal rectifier, type IN34, will, it is claimed, permit higher inverse peak voltages , thus a potential field of use is envisaged in voltage regulators, low frequency oscillators and polarising apparatus. In this rectifier a tungsten wire is in contact with low-tin germanium alloy wafers, 0 015 in thick.

Certain alloys, notably gold-germanium and copper-gold-germanium eutectics, appear to possess important characteristics. Wide investigations into the various systems, including gold-germanium ternaries, have been made, and efficient applications of the Au-Cu-Ge alloys include soldering of gold base alloys, using standard fluxes and heating treatments. These alloys, which expand slightly on cooling, possess a hardness of 200-300 v p.n. and strength of around 55,000 lb. per sq. in. Germanium does not react with carbon so that it may be melted in graphite crucible and the gold—12 per cent germanium eutectic, of a gold colour, has the low melting points of 356°C., exceptional qualities for precision casting and excellent soldering propensities for gold alloys or gold plated articles Silicon provides a similar alloy but is extremely difficult to dissolve in molten gold ; moreover the Au-Si eutectic, owing to easy drossing, is difficult to handle in soldering. The binary alloys are of fine microstructure and, up to 92 per cent gold, expand on solidification and even at this percentage will crack glass containers on cooling. This property is valuable ; for example, an experimental dental inlay, made without the customary correction for shrinkage, has, without detectable corrosion or other disability, been in service now for somewhat more than a year.

ATOMIC STRUCTURE OF ENGINEERING METALS

S. K. GHASWALA,
BOMBAY

IT has been fully established that metals are aggregates of crystals, a crystal being a composite substance whose atoms are arranged in some geometrical pattern. Because the crystals in a metal are so very small and their orientations of position so much at random, metals are usually considered to be statistically homogenous. This is the fundamental assumption made in the theory of elasticity, a theory whose empirical support dates back to the 17th century, and which at present forms the basis of general engineering design.[1] In order to explain the general background of design and strength calculation, this assumption of metallic bodies being continuous (or isotropic) can be taken to be correct. However, in any discussion of the complex phenomena of elastic failure, yield, hysteresis, plasticity, creep, fatigue, strain hardening, and compressibility, the above assumption cannot be rigidly adhered to, because the inner atomic and crystal structure of metals plays a predominant part and has therefore to be fully taken into consideration. The outlines of the study of crystallography were given to the world in 1801 by Haiiys, in his monumental work of four volumes of "Traité de Mineralogie", while the foundations of the study of crystal structure in the form of microscopical metallography were laid by Sorbey in the second half of the nineteenth century. Since then although a good deal of progress has been made in the general branches of crystallography, a full application and understanding of its laws governing the mechanical and engineering properties of metals such as elasticity, plasticity, creep and other allied phenomena, is still lacking.

THE ATOMIC STRUCTURE

The outward manifestations of the mechanical strength of metals such as tensile, compressive, shear and torsional resistance, are a function of their inner atomic structure. In a crystal which forms the basic structure of metals, the atoms have each set free one or more electrons. These negatively charged particles act as a cement binder to the posite charges of the atoms In addition these atoms exert forces on one another and thereby create primary and secondary bonds which can be studied from the principles of the quantum theory. The primary bonds are differentiated from the secondary bonds by their high energy content, and under the former head fall the heteropolar ionic and homopolar bonds. The source of energy contributed by van der Waal's forces fall in the second category. These van der Waal's forces which operate between neutral atoms and concern at least partly the state of zero energy of an atom or electron system, are of a relatively feeble character. The difference in energy between the primary and the secondary bonds, which is approximately one to two orders of magnitude, is manifested outwardly in the

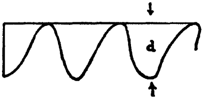

FIG. 1

resistance to mechanical deformation. In addition to these two, there are also valency forces which act for example between metalloids and those elements which lie within the middle range of the periodic system. These forces give rise to both attraction as well as repulsion, the latter characteristic being manifested in the remarkably small compressibility of solid bodies in general and metals in particular. The great resistance which metals offer to a reduction of volume when being compressed, is however also accounted for by Pauli's exclusion principle according to which two electrons can never exist in the same quantum condition in an electron system.

It will be observed from a schematic picture (Fig. 1) drawn for a crystalline body like a metal, that as a result of the regular arrangement of atoms, congruent troughs of depth 'd' are encountered. The atom vibrates in all directions in this trough with a frequency of the order of 10^{13} per second due to thermal agitation, but cannot escape from this trough so long as 'd' is greater than the energy corresponding to the largest amplitude of vibration occurring. If, however, this energy due to thermal vibration exceeds the value of 'd' at a certain moment the atom will attempt to migrate into a neighbouring trough—a multiplication of this process leading to plastic deformation of the metal. From the fact that vibrations of an atom are irregular, it becomes evident that the rate of testing of a metal will have an influence on the magnitude of the yield value and tensile strength. The longer a given tension is maintained, the greater the chance will be that the atom will carry out a vibration with an amplitude sufficiently great to cause it to leave its potential trough, the actual chance depending on the statistical laws of probabi-

lity. Since atomic migration must be taken into account, and since it will be increased by any shearing stress applied, it becomes evident that in strict scientific parlance, no yield value for a metal can exist except at the absolute zero of temperature.

These views on atomic vibrations together with the phenomena of slipping of metallic crystals held by Becker[2] is in line with the earlier conceptions of Tammann, according to which the plasticity of a metallic crystal is affected by temperature the higher the temperature the more frequently the slipping will occur On the other hand however, Polanyi and Schmid[3] have shown that in metal single crystals plasticity due to ordinary slip can be observed at the lowest possible temperatures thereby concluding that one main part of plasticity must be attributed to a mechanism which is not dependent on the thermal agitation of atoms. Many other theories have been put forth and theoretical conceptions evolved in this connection,[4] from which it may be gathered as far as is possible within the limits of our present knowledge that the existence of finite periodic changes consisting of slight variations in the distances within the crystal lattice have to be assumed. Upon the primary lattice of an ideal crystal secondary disturbances are superimposed, these comprising of small periodic variations of the density or of the distances between the elements of the lattice. The structure—insensitive properties (*i.e.*, density specific heat, elasticity, compressibility, thermal expansion etc) are caused by the primary lattice and the structures—sensitive' properties (*i.e.*, mechanical strength, plasticity, dielectric and optical characteristics etc.) by the secondary disturbances. The ideal lattice is thus thermodynamically less stable than the mosaic crystal *i.e.*, a crystal having slight periodic variations in the lattice. It is this secondary structure therefore, within the primary lattice that produce phenomena, outwardly manifested in the lowering of strength and plastic deformation.

The total range of rates of plastic strains which cover the fields of engineering and geophysics is 10^{20} : 1. In fact among the various physical phenomena the plastic flow of solids in general is of special interest because of the extremely wide range over which one important variable on which it depends can vary. According to Dr Nadai[5]—one of the world's most eminent authorities on plasticity—there are few phenomena in the realms of physics wherein the variables change over as large a range as 10^{20}. Only the electromagnetic spectrum surpasses this phenomena of plastic flow as shown by a comparison of equally spaced units in both scales

TABLE I

Plastic Flow of Solids.	Rate of flow per sec	10^{-16}	10^{-12}	10^{-8}	10^{4}
		Geology	Creep in steam turbines	Ordinary material testing	Explosion Damages
Electro-magnetic Spectrum	Frequency per sec	10^{8}	10^{6}	10^{14}	10^{22} to 10^{25}
		Low high frequency Electric Heating	High frequency Heating	Visible Light	Cosmic Rays

Conception of the Strength of Metals

The strength of metals which can be calculated from the principles of quantum mechanics, Born's theory of crystal lattices and van der Waal's forces are found to be some 500 to 10,000 times greater than their 'technical' or actual strength as observed in everyday engineering practice A large difference between the actual and theoretical elastic limit has been deduced from the fact that the latter is some 10,000 times the modulus of shear for the metal in question.[5] This signifies that plastic yielding occurs as soon as the preceeding elastic shear has attained a value of only about 10^{-4}, whereas on theoretical basis one would expect a shifting of atoms in adjoining glide planes over about half the atomic distance corresponding to a shear of the order of magnitude unity. According to Darwin[6], the most characteristic quality of any metal (or of a solid in general) is its shear strength, its maximum value being given by $\frac{G}{2\pi}$, where G is the modulus of shear. For a given good quality steel having $G=6000$ tons per square inch, the maximum shear stress $M=\frac{6000}{2\pi}$ *i.e.*, roughly 1000 tons per square inch, as compared with only 10 tons per square inch actually taken in engineering design.

Several theories[7] have been put forward to account for this discrepancy in strength between the

observed and calculated theoretical values, and although they differ widely in their detailed analysis they are usually based on a common principle first introduced by Griffith[8] in his rupture theory. According to him the presence of inhomogeneities of any kind (*e.g.*, cracks) prevent the applied exterior load from acting homogeneously over the full extent of the specimen in question thus causing a premature rupture as a consequence of stress—concentrating effects. The conceptions of the theory of rupture introduced by Griffith were further investigated by Smekal[9] from a molecular point of view. According to him there are to be found in every real crystals certain faulty places, the so called "Lockerstellen" or flaws where a deviation occurs from the regular structure of the crystal, and in whose neighbourhood stress concentration occurs. The energy concentration at these places (for not too low temperatures) enhances the possibility of "self-diffusion" of the atoms to such an extent that in the neighbourhood of the faults, displacement will occur. As a consequence, on the one side of the given spatial distribution of the applied load and on the other of the anisotropy of the distribution of potential energy as determined by crystallographic directions, the process of "self-diffusion" and also the "slip" process depending on it, will exhibit a statistical preference for certain definite crystallographic directions. The plastic behaviour of a crystal is thus determined in the first place, not by the stress condition existing in the bulk of the crystal but by the special state of energy of a comparatively small number of atoms, which somehow are able to prevent the deformation of the crystal from taking place homogeneously over its full extent.

Smekal's theory was extended by Becker[10] who pointed out the role of thermal motion of the atoms in initiating slip, while Orowan[11] extended this concept to include the effect of flaws which act as stress raisers. The theories put forth by Smekal, Becker and Orowan though successful in accounting for many characteristics of plastic flow in crystals, do not satisfactorily deal with the relative effects of soluble and insoluble impurities nor explain the mechanism by which the flow can leave a point of stress concentration and cross a region of average stress. Recently new conceptions have been put forth by Taylor, Polyanyi and Orowan.[11] Although starting from different points of view, these authors conceive the process of slip as being brought about by the propagation through the lattice of a definite type of deviation the so called "Versetgung", ("Verhakung") which is closely correlated with the shear stress of the metal. A statistical theory has been developed in Russia by Frenkel and Kontorova[12] based upon the assumption that the strength of a crystal as a whole is determined by the most dangerous of all the inhomogeneities contained in it, and that the "degree of danger" of each homogeneity present in the crystal may be specified by the volume of the brittle strength which would be possessed by the crystalline specimen if its destruction, were due to the given inhomogeneity. On the assumption of a Gaussian distribution of possible values of brittle strength it is observed from this theory that the most probable value depends on the volume of the specimen in a characteristic manner. Another Russian development which may have far reaching consequences is the promulgation of a unified theory of strength by Fridman[13]. This theory is essentially based on the theory of maximum deformation which is applicable to those cases where interatomic forces enter into the calculation of the equilibrium of forces in the system , and the theory of maximum shear stress, wherein it is possible to explain the behaviour of metals during plastic deformation and fracture. By the use of a newly developed graph of "mechanical state" it is possible to find the equivalent tension, compression, and shear stress components for any type of stress system

The electron theory of metals which has been recently propounded by physicists[14] has considerably added to the sum total of the knowledge of the physical behaviour of metals and has helped in explaining the resistance of metals to cleavage, the various factors that alter their electrical resistance, and in developing the zone theory of solids and alloy phases.

In spite of all these advances, the theoretical prediction of the exact type of crystal structure that would be the most suitable for any element is a task too difficult and intricate to be propounded from the laws of quantum mechanics and the electron theory in its present state of development.

DEFORMATION OF METALS

The actual phenomena exhibited by metals upon deformation can be broadly classified as under:—

(*a*) *Elastic Range*. Loads of a very small magnitude creating only an elastic strain in all crystallites and intercrystalline matter.

(*b*) *Elastic-Plastic Range*. Elastic deformations of most crystallites occur, with plastic yielding of some parts of intercrystalline matter or even crystallites, in such a manner that when the specimen is unloaded, it resumes its original form, exhibiting perfect elasticity although an elastic after-effect may be observed.

(*c*) *Plastic-Elastic Range*. Both elastic and plastic deformations of the crystallites take place with increasing load, but in this range, upon unloading, the elastically strained crystallites do not have sufficient strength to bring the specimen back to its original form. A permanent set is thus observed in this range.

(d) *Plastic Range.* Complete plastic deformation of the crystallites occur with an appreciable yielding

In the case of most of the engineering metals an exact numerical distinction between these regions is not possible. However it can be broadly stated that the first region (a) is so small that it can be considered as non-existent The "yield value" (*i.e.*, load at which the permanent deformations, however small, becomes apparent) may be considered as the transition between regions (b) and (c) ; while the yield strength which is marked by deformations considerably larger than elastic deformations marks the transition from (c) to (d) According to Laurent[15] the force necessary to produce deformation in a metal is given by F_o plus F_i plus F_t, where F_o is the elastic limit of the metal, F_i a force depending on the nature of the packing of atoms in the lattice and F_t, a force called the consolidation of tensions, which depends on the curvature of the slipping planes and therefore on the geometrical nature of the deformation.

Hysteresis, Damping Capacity, and Fatigue of Metals

The inner tensions arising between the elastically and plastically deformed regions give rise to an elastic after effect commonly observed in polycrystalline metals, a phenomena first discovered by the physicist William Weber in 1835.[16] Closely allied to this is the phenomena of elastic hysteresis (17, 18, 19) which is analogous to the physicists magnetic hysteresis—from which the damping properties of metals can be determined (20, 21) Graphically, the loop formed by two stress-strain curves, one for increasing load and the other for decreasing load, is termed elastic hysteresis The area of this loop is a measure of the work lost during each reversal of loading the work being dissipated as heat The best known example of elastic hysteresis is furnished by cast iron wherein this effect arises as a result of the sliding of the crystals on each other under pressure or of aggregates of crystal grains along the inner surfaces of imperfections. In ordinary single crystals such as zinc and tungsten this effect is practically absent, while in deformable single crystals it may be observed in a very small degree. Due to the part played by the crystal faults in the deformation process, even apparently elastic deformations, may here also be accompanied by irreversible displacements of atoms Thus for example elastic hysteresis was observed by Gough, Hanson and Wright[22] in the case of aluminium crystals for very small deformations A theory, ascribing the elastic after-effects in solid solutions to the possibility of diffusion processes due to an inhomogeneous stress distribution, has been lately put forward by Gorsky[23] and in which connection the question is raised as to how far in "pure" metals the presence of small amount of impurities may also influence the phenomena of elastic after-effect.

The property known as "damping capacity" of metals[24] which is closely related to fatigue, is a measure of the ability of the metal to convert vibrational energy irreversibly to the other forms such as thermal or potential energy within cold-worked crystal structures

The investigation of elastic hysteresis and damping under periodically oscillating stresses leads one to the phenomena of fatigue and creep which play a vital part in the design and utilisation of metals in engineering It is well known that when a metal part is subjected to a prolonged series of repeated loads, more particularly when the stressing is reversed in direction, sudden failure may occur, at a stress far below the ultimate strength of the metal This phenomenon of the decreased resistance of the metal to varying stresses is termed fatigue of metals[25] Early quantitative researches were first carried out on this subject by Fairbairn[26] in England and Wohler[27] in Germany in the middle of the last century, and the work of these two great pioneers was continued by others like Gerber[28], Reynolds and Smith[29] However, the problem of fatigue received a really great impetus quite recently and a systematic investigation of the problem may be said to have begun with the manufacture on a large scale of high speed motor-cars, aero engines and turbines and with the adoption and increasing application of high strength alloy steels and other high strength light alloys of aluminium and magnesium to meet the needs of modern engineering developments. During the last 2 or 3 decades a considerable amount of work has been carried out at the N P L Teddington ; England, the Eng. Expt Station of the University of Illinois , the U S. Naval Eng Expt Station the U S Air Service Laboratories, and in Russia, and although a good deal of information on the question of fatigue of metals has accumulated, the molecular theories of fatigue failure of metals are still far from being perfectly understood. The recently propounded Russian statistical theories of fatigue may further throw some light on this vexed problem[30].

By employing X-ray methods of precision and devoting special attention to the effect of stressing on the inner structure of metals, Dr Gough[31] at the N.P.L England, was able to conclude for the first time that failure under static and fatigue stressing is associated with changes under crystalline structure which are identical. These changes involve in the first place a dislocation of the initially perfect grains into large components which vary in orientation from

that of the internal grain by amounts upto about 2 degrees; secondly crystallites are formed approximately 10^{-4} to 10^{-6} cm in size, the orientation of which varies greatly from that of the original grains, that several internal stresses are present in the crystallites, so that at facture the whole specimen behaves as a medium of crystallites showing marked lattice distortion and oriented completely at random

The Phenomenon of Creep

The phenomenon of creep of metals is recognized as the slow plastic deformation with time under a constant stress[32] and is distinguished from 'slip' from the fact that in creep the flow takes place at rates slower than slip. Creep which plays an important part in engineering design of metals, has to be limited for safe design depending upon the nature of the component and the service condition Thus in the case of steel the permissible limit is 10^{-9} inch/inch/hour for turbine rotor wheels shrunk on shafts; 10^{-7} in./in /hour for steam piping, welded joints and boiler tubes, and 10^{-6} to 10^{-5} in /in /hour for superheater tubes In spite of several investigations being carried out, a full interpretation of creep in relation to the atomic structure of metals does not appear to have been achieved as yet Investigations carried out on single crystals of pure lead and tin, and on crystal aggregates of lead and its alloys by Moore[33], Greenwood[34], Mckeown[35] and others have clearly brought out a fact that the intercrystalline mechanism of creep in metals is probably far from being of a simple nature Thus in the case of steel, spheroidization of the cementite and volume changes due to precipitation of the constituents, have been found to affect creep rates, while other phenomena known from the observations on the plastic flow of single crystals and of crystal aggregates, such as slip, irregular change of the position of the atoms in the lattice (the so-called "Paltzwechsel"), recrystallization, and localized flow by means of "Platzwechsel" along the grain boundaries, have been noticed having a profound effect on the shapes of creep curves It is evident from these facts that in the present state of knowledge it is very difficult to concentrate efforts for predicting quantitatively the behaviour of metals from a molecular point of view, when they are subjected to both stress and temperature in a widely differing manner. Nevertheless, even in such conditions, metallurgists, physicists and engineers have not ceased and probably will not cease for some time in their further efforts to investigate the various aspects of the phenomenon of creep, and plasticity and their role in engineering design[36]. Although the plastic properties of polycrystalline metals[37] in the region between the solid and liquid states which presumably depend on viscosity, strain hardening and annealing, are at present very meagrely understood, it is believed that some very reasonably simple principles lie behind these apparent entities. In fact a mechanical analysis of these phenomena is one of most useful tools for their exact investigation, on account of the immediate necessity of shortening the time for testing the creep of metals, for predicting the creep to be expected for longer period of time from short observations, and for extending the investigations to the problems of combined stress. More obscure in its relation to the phenomena of creep and internal friction is microcreep, which appears as a result of the flow of molecular dislocations already present in the metal, and unlike creep, is not recoverable on removal of applied load

In view of the fact that much has been published in the last few years on the phenomenon of creep of metals, it would not be out of place to briefly consider at this juncture its actual stage of progress. At present all observations made on the occurrence of brittle intercrystalline fractures after long test periods can be explained by the help of certain conceptions first put forth by Rosenhain and Ewen as far back as 1912[38] The lack of comprehension hitherto prevailing as to whether the creep phenomenon at high temperatures is to be attributed to the actual grain boundaries slipping apart or to conditions in the mass of crystals are explicable by making a distinction between the position-change phenomenon and the actual sliding apart of the grain boundaries Only the occurrence of brittle intercrystalline fractures after long periods of time can be connected with the processes which occur in the actual grain boundaries All other phenomena such as the dependence of the rate of creep on load and temperature, and influence of the structure of material, and in general all phenomena which can be found from comparatively short time tests are explained by the processes occurring in the crystals either by actual movements of translation or by place-change plasticity. Thus, the influence of the size of grain on the creep properties at different temperatures has according to Burgers[39] been fully accounted for by the amorphous plasticity becoming less as the grain size increases. In a paper read before the American Physical Society, some years back, Seitz[40] pointed out that two different qualitative pictures can be used to discuss creep to a certain extent in single crystals on the basis of the theory of dislocations. According to him, the rate of creep is determined primarily by the relatively slow motion of dislocations present in the solid and secondly that the dislocations move almost instantaneously and that creep is therefore mainly tied up with the rate of generation of these dislocations.

ELASTIC MODULUS

Among the other properties which play an important part in engineering design mention may be made of Young's Modulus of Elasticity. The directional dependence of the elastic moduli in polycrystalline metals is dependent upon the orientations in the specimen and can be semiquantitatively predicted from the anisotropy of single crystals. The maximum value of Young's Modulus in face centred cubic crystals is along the (111) direction and the minimum along (100), the actual value of the former being about three times that of the latter in most face centred cubic metals (except aluminium which is nearly isotropic). The large variation in the elastic modulus of metallic wires with annealing must arise from alterations in texture since the elastic constants are almost unaffected by cold work and recovery. An example is the drop in the Young's Modulus from 18×10^6 lbs./sq. inch to 13.4×10^6 lbs./sq. inch when hard drawn copper wire is annealed. This is due to the varying amounts of material in the two positions of wire texture (111) and (100) with annealing.

GENERAL REVIEW

The evaluation of the various engineering properties of metals in the light of atomic physics has taken place very recently and as such a wide and potential field of exploitation still remains to be explored.

It had been first thought that the cohesion of the inner molecules in a metal might be due to the result of the well known forces of gravitation while actually they have been proved to be due to atomic forces of far greater power. The study of single crystal specimens which is usually undertaken to understand the behaviour of polycrystalline pieces reveals the fact that such single crystals are not strong but very soft and show remarkable strain hardening properties. Single crystals are generally anisotropic and the formulas relating stress to strain must take account of the variation in Stiffness of a crystal in different directions, many more constants of proportionality being required than for isotropic materials. The relation between stress and strain is defined by the generalized Hook's Law and is applicable not only to metals but to any homogeneous body.

According to E. N. da Costa Andrade[4] an ideal crystal when stressed should have a brittle fracture within the elastic limit under tension or an unlimited glide under shear and should show no hardening under plastic flow. Polycrystalline metals do show these characteristics to a certain extent although a full realization of this ideal state is beyond the bounds either of the metallurgist or the engineer in the present state of knowledge.

The anisotropic properties of a metal are altered when it is cold worked. Thus the electrode potential, thermal expansion, compressibility, coercive force, and electrical resistance are increased (the last usually about 2 per cent but 18 per cent in the case of molybdenum and 50 per cent in tungsten) while the temperature coefficient of electrical resistance, thermal conductivity and maximum permeability are decreased. Some of these changes may be due to changes in the physical properties of the individual grains and some may be due to changes in texture or a combination of both. The resistance of metals to cleavage arises due to the electrostatic attraction since any force tending to pull the ions apart also tends to increase the average distance between these ions and their neighbouring electrons. The fact that disarranged atoms at a grain boundary do not appreciably reduce cohesion across the boundary explains why a metal does not disintegrate even when slip takes place for it is evident from the above that even in spite of a very high state of disorder approximating a molten condition at the slipping surface there still remains the electrostatic attraction holding the crystals together. The increase in the resistance of metals with temperature is interpreted as the result of thermal vibration of atoms interfering with the motion of the conduction electrons while its resistance which also increases with impurities or alloying is accounted for by the distortions produced in the lattice by the foreign atoms.

Along with elasticity, plasticity of metals also plays a very important part for if structural members did not have the ability to accommodate themselves to the redistribution of stress through this characteristic of plasticity, no buildings, dams, bridges and other structures would ever stand up no matter what numerical factor of safety was used in their designs by the Theory of Elasticity. An outstanding property of metals is their high electrical and thermal conductivity, a property of current flow which is now known to be carried entirely by electrons. In general the electrons—and primarily the valency electrons[42] of the atoms—play such a conspicuous part that while investigating the theory of conductivity of metals and the theory of the binding forces which exist in the metal structure it is only necessary in the first place to consider these electrons and subsequently to examine their mutual action with the lattice as a subsidiary phenomenon. In its present state of development metal electron technique can only be investigated rigorously by means of wave mechanics. This procedure is capable of yielding basically important information

on the electronic character and properties of metals as well as insulators The problem of the emission of electrons from metals, which dominates the field of nuclear physics is of fundamental importance in electrical engineering, especially in the design and construction of radio valves, photo-cells, X-ray tubes and other electronic appliances In order to predict the magnitude of the thermal and electrical conductivities and in particular their dependence on temperature, it is necessary to take into account the mutual action of the electrons and the crystal lattice This branch of metal electron technique is the most difficult to handle and is still far from being perfectly understood

Another unsolved problem in these realms is the phenomenon of supra-conductivity of metals,[43] a phenomenon which has actually been known for the last 30 years, but whose solution has not yet been fully traced out The peculiar characteristic, exhibited by certain metals of showing no measurable electrical or magnetic resistance when cooled below a certain critical temperature is known as supra-conductivity. So far this property is known to be exhibited by the metals thorium, lead, thallium, mercury, tantalum, tin, indium, niobium, gellium, and titanium The critical temperatures lie mostly under 10° absolute and for the present, the lowest critical temperature of 15° absolute is exhibited by thorium At the approach to the supra-conductivity condition it appears as though the electrons suddenly become able to travel through the metal lattice without frictional resistance and also to continue to travel so for long periods after the externally applied driving action has ceased to operate Metals in the supra-conducting state cannot be magnetised, they are absolutely diamagnetic, and it is only when the stress of the impressed magnetic field exceeds a certain critical value that the magnetic lines of force are able to penetrate into the metal and when this takes place the supra-conductivity is destroyed[44] It is of interest to observe that the supra-conductors mainly occupy the central range among elements of the periodic system Whether supra-conductivity will play an important part in any technical or engineering work in future is a question which cannot be easily answered Even if it does become possible to produce alloys or compounds which will have critical temperatures much higher than any yet known, the fact that supra-conductivity disappears in relatively weak magnetic fields, such as of the order of 100 Oersted, will still be a stumbling block to any extensive technical applications

Conclusion

It has been rightly said that the material progress of mankind is closely connected with the progress of materials Judging by this criterion, the present century has witnessed greater material progress than in any other corresponding period of time, a period during which the development and utilization of metals and alloys have revolutionized in many ways the life, comforts and happiness of man on this globe Continued investigation and research into this field of technology of metals, which rests fundamentally on the four pedestals of physics, chemistry, metallurgy and engineering, will undoubtedly open out new avenues of approach in the hitherto unchartered realms It was that distinguished scientist Sir William Bragg, F R S, who once said:

> " . No knowledge could have been more welcome to the metallurgist on whom demands are now made for the supply of materials of new and extraordinary qualities Every variety in the behaviour of an alloy can be traced to the arrangement of the atoms in the unit of pattern of its crystals Of possible combinations to form alloys there is no end, and it can be readily understood that knowledge of structure is of the highest value in planning the course of research Such knowledge is growing rapidly We in this country (i e, England) have compelling reasons for developing to the utmost our knowledge and practice of metallurgy "

As far as this country is concerned, the last sentence of Sir William Bragg may well serve as an eye opener, for although metallurgical research is being carried out here, nevertheless the development of the fundamental investigations regarding the engineering properties of metals in relation to their inner atomic structure, is still lacking. It is hoped that these investigations will be energetically carried out in the newly proposed National Physical and National Metallurgical Laboratories In these highly technical and scientific laboratories there would be ample scope to carry out research into subjects covering such fields as the processes of slip, twinning and fracture and the theories governing these processes; the effects of cold work and annealing on the structure of metals; preferred orientations resulting from cold work, hot work, etc; the computation of the anisotropy of polycrystalline aggregates, the relation between the crystal strength and atomic force in polycrystalline metals; the interpretation of the Young's Modulus of a metal as a function of its atomic volume and specific heat[45], the phenomena of strain hardening, age hardening and inter-crystalline corrosion and cracking and their influence on stress distribution; directionality in commercial metals and in single crystals and its relation to crystal orientation; development in supraconductivity; the molecular behaviour of metals during fatigue, creep and microcreep; elasticity and plasticity of metals during very low and very high temperatures; compressibility of, and plastic flow in metals[46]; a clear exposition of the fundamental properties for describing the strength of metals[47];

and obtaining a deeper knowledge and understanding of the principles of quantum mechanics and the electron theory of metals in evaluating the strength of metallic structures and the development of metallurgical processes tending towards the production of ultra-high strength alloys It is only by a close co-operation between the physicist, the metallurgist and the designing engineer, that the utilization of metals, which today represent the most predominant engineering materials, can be further enhanced for economic, industrial and national welfare.

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MEDICINE AND PUBLIC HEALTH

PHARMACEUTICAL PROBLEMS OF INDIA

Some of the most important pharmaceutical problems of India have been reviewed by Mr Mahadev Lal Schroff in his Presidential Address before the 7th All-India Pharmaceutical Conference held at Delhi from 3rd to 5th January, 1947. Particular attention has been drawn to the subject of pharmaceutical legislation, pharmaceutical education, and pharmaceutical industries.

In spite of the constant agitation in the Legislatures since 1927 and publication of the Reports of the Drugs Enquiry Committee in 1930-31, the Government of India have not done very much towards the enforcement of legislative measures for drug control and reform Though a Drugs Act has been passed in 1940, this has not yet been enforced, and considering the very slow rate at which the Government of India are moving towards the establishment of necessary machinery for the functioning of this legislation, it appears that there is hardly any likelihood of its being put into effect from April, 1947, which has been announced as the official date of its enforcement A Pharmacy Bill was also placed before the Assembly, but due to the confused thinking of a number of members, this Bill has been referred back to a Select Committee, and there is no knowing when it will actually come into force In addition to these two pieces of legislation, Mr Schroff recommends that there should be a 'truth-in-advertisement Act' and also another law for the control of harmful cosmetics, therapeutic devices and indigenous drugs. Under the garb of 'indigenous medicine', a good deal of adulteration is being practised and many cases of mis-branding, which should have been otherwise penalized, are being permitted to escape notice of the controlling authorities. It is desirable to face these problems and find out a remedy in the interest of public health of India. There is also an urgent need for the control of false and exaggerated advertisements regarding drugs

Pharmaceutical education has been developing in India in an altogether haphazard fashion. There is neither unity of thought nor of purpose There is obviously need for a uniform system of education all over India, and for this purpose, Mr Schroff recommends that there should be two courses of training—a junior course of a sub-University standard for the retail and dispensing pharmacists, organized and controlled by a Pharmaceutical Society, and another of a University standard more or less on the lines of the new syllabus of the London University for the B. Pharm. Degree. Mr Schroff has rightly pointed out that pharmaceutical education has so far been badly neglected in this country and the time has now come when this must be re-organized on modern lines, so that trained personnel would be available for the nation's growing pharmaceutical industries.

Regarding pharmaceutical industries in India, Mr Schroff is of opinion that, if certain obstacles which are standing in the way of pharmaceutical development are removed, there would be a promising future. Attention should be paid, according to him, to the quality of packing materials, the crude drugs available in the local market, the freight charges, the removal of provincial excise laws and to the manufacture of pharmaceutical equipment in India. The export and import policy of the Government of India also needs radical changes and should be brought in line with India's national interests The tendency amongst Indian manufacturers to undertake the manufacture of all types of products and not specializing in any particular line, to which they are advantageously placed regarding raw materials, equipment, personnel, etc , has been deplored. The lack of co-ordination in industries is another factor which has been adequately stressed. Without co-ordination, the growth of main and subsidiary industries are bound to suffer. He has also deprecated the rapid increase in the growth of foreign manufacturing and distributing establishments in India under the cloak of 'India limited' and has made pointed remarks to the slave mentality prevailing amongst many members of the medical profession for their preference to foreign products in place of products manufactured in India Along with the usual lines of manufacture, Mr Schroff stresses that the manufacture of anti-biotics, such as penicillin and streptomycin, and other synthetic and chemotherapeutic drugs should also be undertaken in hand In such attempts, Mr Schroff feels that the State should come forward and start the industry and when it is properly organized, the State should turn it over to desirable manufacturing concerns who have the proper type of technical personnel and apparatus to carry on the work under controlled conditions.

The remarks made by Mr Schroff regarding pharmaceutical problems of India are apt and pertinent and require the serious attention of all those

who have at their heart the development of pharmaceutical enterprises in this country. There is undoubtedly need for drug control and standardization, without which no modern industry aimed to cater for the public health can hope to exist During the last war, there was a welcome sign of the rapid development of pharmaceutical industry, and if this progress is to be maintained, attention should be immediately focussed to the removal of some of the obstacles, which has been pointed out by Mr Schroff It is to be hoped that both the Indian industrialists and Members of the National Government would pay more attention in this direction than had hitherto been done.

THE WORLD HEALTH ORGANIZATION

The United Nations Conference on International Organization, which met in San Francisco on April 25, 1945, introduced the world "health" in applicable sections of the charter of the United Nations, dealing with international economic and social co-operation. For the first time emphasis was laid not upon quarantine and checking epidemics and other defensive measures, but upon positive, aggressive action toward health in its broadest sense The preamble declares that "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity". This standard of health is defined as one of the fundamental rights of every human being.

The Economic and Social Council of the United Nations, convened a Technical Preparatory Committee on Health, which met in Paris on March 18, 1946, and an International Health Conference, which met in New York City from June 19 to July 22, 1946 On the last day of the latter conference, 61 nations signed the constitution of the World Health Organization, the first fully empowered international agency in public health.

The committee that met at Paris was composed of 16 experts from Argentina, Belgium, Brazil, Canada, China, Czechoslovakia, Egypt, France, Mexico, Norway, Poland, U K., U S A , Yugoslavia and India (represented by Mani and Katial). The U.S.S R. declined the invitation. Dr Rene Sand (Belgium) acted as chairman of the committee The proposals as agreed upon by this preparatory committee were circulated among all members of the United Nations.

In the International Health Conference, delegates from 51 United Nations took part in the deliberations. Besides, non-member nations, 3 allied control authorities (Germany, Japan and Korea) and 10 international organizations (including F.A.O , Rockefeller Foundation, UNESCO, and UNRRA) attended as observers Afghanistan, Rumania and Yemen though invited were unrepresented Dr Parran, Surgeon General of the U S Public Health Service and chief delegate of the United States, was unanimously elected as president of the conference. The Soviet Union participated in this conference by delegates led by Dr Krotkov, Deputy Minister of Health. The Conference decided to absorb the role of existing international organizations dealing with public health (*e g* , the office of the International d'Hygiene Publique, health section of the League of Nations, epidemiologic intelligence of the health section of UNRRA), by the World Health Organization.

The world Health Organization will come into being when 26 members of the United Nations ratify the signatures of their delegates An interim commission has been set up, to conduct essential business of the organization etc , for the period between the conference and the first meeting of the W H O This commission consists of 18 nations, including India.

The functions of the organization are defined as follows (*a*) to act as the directing and co-ordinating authority on international health work, (*b*) to stimulate and advance work to eradicate epidemic, endemic, and other diseases (*c*) to promote, in co-operation with other specialized agencies where necessary, the improvement of nutrition, housing, sanitation, recreation, economic, or working conditions and other aspects of environmental hygiene, (*d*) to protmote maternal and child health welfare and to foster the ability to live harmoniously in a changing total environment, (*e*) to foster activities in the field of mental health, especially those affecting the harmony of human relations, (*f*) to promote and conduct research in the field of health, (*g*) to promote improved standards of teaching and training in health, medical, and related professions , (*h*) to provide information, counsel, and assistance in the field of health, (*i*) to establish and revise as necessary international nomenclature of diseases, of causes of death, and of public health practices, (*j*) to develop, establish, and promote international standards with respect to food, biological, pharmaceutical and similar products , etc

The first task of W.H O will concern with the age-old scourges of men, accentuated by the devastation of war. The need is urgent for caring the sick and wounded, feeding the hungry, controlling epidemic diseases and by pooling the resources of all nations eliminate such diseases as malaria, tuberculosis, and syphilis

Beyond the immediate needs, the W.H O will have a long-term plan to protect people from ravages of disease, insure a standard of health to every individual compatible with the technical achievements of the medical sciences.

RECENT IDEAS ON THE CAUSE, THEORY AND TREATMENT OF DIABETES

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GRADUAL INCREASE IN INCIDENCE

IT has rightly been pointed out by Joslin[1], Merchant[2] and several others that in almost all civilized countries, during recent years, the incidence of diabetes has been known to rise gradually and steadily to a fearful degree, and no measure has yet been possible to check it or to keep its incidence under control. It is really alarming to note that in Vienna alone the increase in fatal cases of diabetes, from 1926 to 1935, has been found to be 85 per cent Discovery of insulin and its use by Banting and Best[3] have no doubt been useful to a great extent to reduce, in some countries, the percentage of premature death through this disease, but the ailments and troubles of the suffering humanity have not been lessened to a considerable extent. Increase in the concentration of glucose in blood and its elimination in urine, which are still regarded as the main symptoms of the disease, have been checked and prevented, but the idea, that these are the effects and not the causes of the disease, has always been lost sight of.

VIEWS ON THE ONSET OF HYPERGLYCEMIA

(i) *Lack of insulin (pancreatic origin).*—An absolute or relative lack of insulin has frequently been known to cause failure in the regulation of blood sugar and to give rise to the condition of hyperglycemia and glycosuria

(ii) *Hepatic origin*—Mann[4], Soskin[5], as well as Roy[6] are of opinion that the liver is the sole source of supply of glucose in the blood and is primarily responsible for the onset of hyperglycemia. Motzbeldt[7] discussed how diabetes mellitus may have its origin from liver and how insulin is of slight value in those cases That the metabolic disturbance in diabetes is due to an alteration in the balance between the hepatic glycogenesis and glycogenolysis gas have been shown by Mirsky and his associates[8].

(iii) *From high protein and fat diet*—Roy and Mukherjee[9] hold that the first stage in the development of hyperglycemia is a condition of acidosis, resulting from the faulty method of living, especially on high protein and fat diet.

(iv) *Defects in glycogen formation.*—Lawrence[10] and Joslin are of opinion that formation of glycogen, the body reserve for glucose, is dependent on the action of insulin But works of Dambrosi[11] and Lukens *et al*[12] show that restoration of muscle glycogen after loss through exercise, may take place almost completely even in depancreatic animals, though the rate of such restoration is a bit slower.

(v) *Deficiency of insulin kinase and disturbance in glucose metabolism.*—Himsworth[13] suggests that insulin, as secreted by the pancreas, is physiologically inactive and is activated by some unknown factor which he termed as "Insulin Kinase" Several observers have noticed that in some cases of diabetes mellitus insulin is of little use. Himsworth[14] has classified diabetes into two groups (*a*) insulin sensitive and (*b*) insulin insensitive and according to him the latter type suffers entirely or partly from the deficiency of some unknown factor

(vi) *Factors causing defect in glucose metabolism.*—This hypothesis has, in recent years, been strengthened by the work of Nath[15] who reports isolation of a drug called *Amellin* and suggests that this compound may be related to this unknown factor and deficiency of this type of substances might cause disturbance in general metabolism and give rise to the conditions of hyperglycemia associated with lipemia, cholesterolemia, creatinuria, uremia, ketonuria and other troubles Works of Nath and Banerjee[16] give some confirmatory evidence of this view, who found that amellin can bring about relief in hyperglycemia and glycosuria in a way somewhat different from that of insulin. Though the lowering of sugar content does not begin immediately—rather there being observed initial rise in some cases—there is an all round improvement in all the metabolic troubles specially of cholesterolemia[17] and high inorganic phosphate content of the blood[18]. Blix[19] and several others pointed out that the lipoid constituent of blood increases in clinical cases of diabetes and Man and Peters[20] observe that the change in the cholesterol content of the blood runs parallel with the change of total lipoids Rabinowitch[21] believes that the plasma cholesterol is the valuable index to the true progress of the diabetic patients. Hence the better way of treating a diabetic is to bring about the lowering of the sterol-content of blood than to cause a fall of blood sugar, which has been suggested by recent thinkers to be of great use for causing elimination of those substances responsible for the onset of the disease.

Newberg[22], Rabison[23] and others have isolated hexose—diphosphoric acid as the intermediate product of carbohydrate metabolism and the defect in this process brought about by any factor whatsoever is accompanied with decrease in such esterification

and increase of inorganic phosphate in the blood Works of Blatherwick *et al*[24] have shown, however, that intravenous injection of glucose can cause fall in inorganic phosphate of the blood thus indicating the necessity of excess concentration of glucose in diabetes and possibility of the presence of substances other than glucose which are responsible for bringing about the trouble Attention has to be paid therefore not to reduce the glucose concentration in blood at the outset without paying heed to tissue catabolism or inability of the system towards esterification of glucose with phosphoric acid

High Protein Theory

Wilder *et al*[25] have shown that when a high protein diet, especially meat, is prescribed for a diabetic individual his condition soon becomes serious and this can be remedied by substituting this by carbohydrate and fat Petren[26] is of opinion that a diabetic requires less protein than a normal person thus indicating clearly that protein metabolism gets severely disturbed in case of diabetes mellitus and warrants the diabetics against taking excessive meat, eggs etc until the metabolic disturbances are properly restored Carrying soil to the banks of a river which is in fury, is of no good unless and until the river can be made to resume its normal appearance The recent view, as accepted by many, is that diabetes is a type of wasting disease characterized by excretion of high urinary non-protein nitrogen Lauter and Janke[27] observe that excretion of nitrogen is very great in case of severe ketoses and elevation of protein nitrogen in the blood in acidosis has been noticed by Bulger *et al* [28] thus showing that food and body protein are sacrificed wastefully

The word 'diabetes' originated from the Greek word 'syphon' and was used by Aretaeus even in the 1st century A D to mean "melting down of the flesh and limbs into urine[29]" This idea has recently been confirmed by Nath and Chowdhury[30] and Nath and Brahmachari[31] who have shown that the elimination of urinary nitrogen in diabetics is far greater than the normal figure and that this is caused mainly by the toxic metabolites accumulated within the system due to disturbance in proper metabolism

Adiposity and High fat Diet

Though Joslin[32] and many others regard adiposity as the precursor of diabetes, little was known till the works of Nath and Brahmachari[33] that the intermediary fat metabolites such as β-hydroxy butyric acid, acetoacetic acid etc. are at the root of the onset of diabetic conditions. Koehler, Windsor and Hill[34] showed that these products can cause increase in concentration of acetone bodies in the blood of normal animals and it is quite likely that glucose might play the part of an antiketogenic factor, thus necessitating its increase in concentration or retention in blood in higher level That excess concentration of glucose alone has no damaging influence on the β-cells of the islets of Langerhans has been shown clearly by Houssay and his associates,[35] who injected it intravenously to the experimental animals for several days

Significance of the Rise of Sugar level in the Blood

The idea that glucose is not a pathological constituent in the blood of diabetics and its increase in concentration is the result of some physiological response, has been laid down by Roy[6] and confirmed recently by Nath and Brahmachari,[33] who observed that there is gradual rise in blood sugar, after the injection of intermediary fat metabolites, which shows but little tendency to come down to the original value even after several hours When a second injection is given on the next day there is again some rise in the sugar level and when this is continued for several weeks a condition of distinct hyperglycemia sets in

Works of Young[36] and Richardson and Young[37] have shown that repeated injection of anterior pituitary extract can cause symptoms of diabetes mellitus when injected in normal dogs

Shaw Dunn and his co-workers[38] and several others have also shown in recent years how the keto-compound, alloxan can bring about symptoms of typical diabetes mellitus only after a few injections or even a single injection at a larger dose, in dogs They supposed that alloxan might be formed in the system though no direct evidence has been found thereof But it is known that alloxan is a derivative of uric acid and the retention of uric acid in the blood, which results into gouty condition, has often been found to be associated with diabetes and Schillenheim and Chrometzka[39] observe that uric acid is oxidized to allantoin through the activity of liver Grafe[40] remarks that gout is most closely related, by heredity and constitution, to obesity and diabetes. As there are many facts indicating an inter-connection between these three metabolic diseases, it can be postulated that some derivatives of uric acid formed within the system along with the intermediary fat metabolites—possibly the keto and hydroxy compounds—are responsible for bringing about an excess concentration of sugar in the blood. The statistical observation that the disease diabetes is almost unknown to

Japanese and to the labour class people in India, whose food consists of rice alone with but little protein and practically no fat, also shows beyond doubt that high carbohydrate diet is not the only factor responsible for the onset of the disease. That glucose plays an important role in anti-ketogenesis, though suggested long ago by Geelmuyden[41] (1904), could not be stated clearly till the works of Shaffer[42]. In order to find out some more definite proof about this hypothesis attempts were made to prepare condensation products of glucose with some keto compounds and these were successful through the efforts of West[43] and Moore, Erlanger and West,[44] who showed that glucose can be made to condense with aceto-acetic ester. The recent findings of Muller and Varga[45], Szeki and Laszlo[46] and Jones[47] have also confirmed nicely how glucose forms condensation products with β-di-ketones. These works have given new light into matter how the keto products can be eliminated through the agency of glucose, the excess concentration of which is greatly needed if they occur in the system and how the high level of sugar in blood, during some metabolic troubles, is beneficial rather than being detrimental to the body. These findings also explain how Roy[6] could bring about relief in some cases of diabetes only by intravenous injection of glucose and how all the patients under amellin treatment began to feel better in all respects, though the blood sugar values did not show any sign of falling for the first few weeks or months.[16] Joslin, who studied the effect of insulin in hundreds and thousands of cases made a remark that "a man taking insulin is like a rapidly moving machine, and a slight swerve of the wheel will bring to disaster"[1]. This remark can be justified and strengthened through the recent findings that *"Glucose is but an effect and not the cause of the disease which had so long been considered to be." Moreover diabetes can be classed as a wasting disease characterized by high urinary nitrogen excretion or by the high level of blood non-protein nitrogen*[40] *and it can rather be said to be a disease of liver than a disease of pancreas alone.* When the toxic metabolites go on being accumulated through the viscious circle, set in within the system, due to indolent habits of taking excess meat and fat diet, the liver gets damaged and its detoxifying capacity is gradually lost. Once the liver is damaged, there is disturbance in glycogen balance and the possibility of gloco-neogenesis (formation of glucose from non-carbohydrate source) sets in. Not only this, it has recently been shown by Nath and Brahmachari[48] that insulin can be inactivated by the toxic metabolites. Hence even if insulin is secreted in the usual way from the pancreas, there is every possibility that it is soon inactivated and this also shows another way of keeping up the high level of sugar in blood and urine.

How to combat Diabetes in the real sense of the Term

In order to combat the incidence of this disease which is eating to the vitals, especially of those in the most advanced countries of the world and which is depriving the human race of the best intelligentsia, it is high time for the scientific world to go to the root cause of the disease and not to relieve the effects alone. All the alarming symptoms of diabetes *e.g.* pyorrhoea and other pyogenic troubles including furunculosis, gangrene etc., defect in vision and hearing, obesity, neuritis, heart troubles, acidosis, albuminuria, creatinuria and even acetonuria along with glycosuria and hyperglycemia, are sure to be relieved if the general metabolism can be made to set in proper order through the administration of some such compound or compounds which can either help in checking the formation of those toxic etiological factors or in eliminating those through the excretary organs in the form of non-toxic substances or by causing oxidation etc.

One had to visualize, that by mere calling the constables off from their posts without paying heed to the culprits laying in some hiding place nearby cannot and will not bring about the healthy and safe atmosphere. If the evil-doers can be searched out, caught hold of and rectified the demand for excess concentration of forces will be gone for ever. It is then and then alone when one can conceive of real peace and eternal joy.

Many works have been done to do away with the individual symptoms of several types of diseases, both curable and so-called incurable, in all parts of the world, but yet the incidence of diseases have not been checked. Real alleviation of human sufferings, caused through diseases, will only be achieved when it will be possible to find out the cause of ailments and to treat this cause and not the disease. May this new angle of vision play supreme in the minds of all scientists and physicians and shower blessings on the suffering humanity and bring forth a new era of peace and prosperity in all the living souls on earth.

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BOOK REVIEWS

Merrilleana—a selection from the general writings of Elmer Drew Merrill edited by Frans Verdoorn *Chronica Botanica*, Vol. 10, No. 3/4 (1946), Pp. 127-394, with illustrations. Published by the Chronica Botanica Co; Waltham, Mass, Macmillan & Co, Ltd., Calcutta. Price $4 00

To mark the occasion of the seventieth anniversary of the birth of their distinguished co-editor, the editors of *Chronica Botanica*, are to be congratulated for bringing out this volume, consisting of an authorized collection of Dr Merrill's principal general writings, as well as a chronological biography and bibliography, as a fitting tribute to the works of the pioneer American Plant Taxonomist. These studies are not so well known as Merrill's purely taxonomic and administrative activity, but they are of wide general interest and have a great and permanent value.

Merrill published his first paper in 1899 entitled 'Notes on Maine Plants' (*Rhodora* 1) and up to now he has published more than five hundred original papers in various branches of taxonomic botany and of general interest. Out of these, the editors could do very little justice in selecting only 23 articles for this commemoration volume. The first article is entitled 'The ascent of Mount Halcon, Mindoro' (*Phillipine Journal of Science*, Vol. 11, 1907) and the last is entitled 'Further Notes on Tobacco in New Guinea' (*American Anthropologist*, Vol. 48, 1946). It is not possible in this brief review to dwell in greater details of the merits and the manifold pioneer works of Merrill in Taxonomic Botany and it is now left to the readers of *Merrilleana* to satisfy their curiosity about the works of the "American Linnaeus" by reading this book for themselves.

A. K. G.

Plant-Hunting in China—By E. H. M. Cox Pp. 230 with 24 full page illustrations and a frontispiece in colour. Published by Collins, London, 1945. Price 12*s*. 6*d*.

This book present a history of botanical exploration in China and the Tibetan Marches and specially of the country from where a large percentage of garden plants growing wild in China were collected by explorers from the very early times down to the very recent. The first period of this exploration took place at a time when China was completely closed to all European influence and intercourse except for a few treaty ports when the men of the Honourable East India Company were able to introduce the finest forms of the Chinese garden flora *e.g.*, cammellias and Paeonias, Azaleas and Chrysanthemums. The second and the recent period is marked by the ex-

plorations of the great collectors like Wilson, Forrest, and Kingdon Ward It is only on reading what they accomplished that we realize what a debt we owe to the magnificent flora of China and the men who gave up the best years of their lives to plant hunting. The bulk of the book is devoted to the efforts of the British Botanists and although a few pages are given to the work of American collectors, it is unfortunate that there is no mention of the works of Merrill, whose contributions to the Flora of China are invaluable

This fascinating history of plant introduction during the last two and half a century is told with a lively interest and the book may be read with profit by botanists, and plant explorers alike

A. K G

Trace Elements in Plants and Animals—By Walter Stiles, M.A., Sc.D., F L.S , F R S Cambridge University Press Pages 1888 with 12 Plates, 1946. Price 12/6 net.

WITH the development of our knowledge of the various problems on Plant Nutrition, the role and importance of trace elements or micro-nutrients in the growth and development of plants and animals have only recently been realized A large amount of work has been done within last twenty years and the above book is a very timely publication as Prof. Stiles has tried to bring together all the important available publications in an easy and objective manner, pointing out their importance and suggesting possible lines of further investigations to understand the physiology and function of the trace elements which are essential for the lives of plants and animals. In the end a comprehensive bibliography is given The book opens with a historical introduction giving an account of the gradual development and realization of the importance of some trace elements in water culture experiments and a list of certain elements like Manganese, Zinc, Boron, Chlorine, Copper, Tungsten and Gallium—together with a list of species of plants in which they have been claimed by different workers as essential for their growth and development. A chapter has been devoted to methods of investigating micro-nutrient-elements and diagnosis of mineral deficiencies of plants. The important known diseases and the external symptoms the cause of which has been traced back to the absence of certain trace elements have been described with illustrations under trace element deficiency diseases of plants The function of the trace elements is still not understood properly and in many cases it is more or less a conjecture, but a comprehensive account of different theories with co-ordinated experimental data so far available, have been described to give an idea of the possible function of these essential elements in the living process of plants *e.g* Oxidation-reduction Process

The importance of certain trace elements in cattles as illustrated by Feeding or Grazing experiments on different pasture lands deficient in certain essential elements have also been described thus showing the essential nature of the trace elements both in animals and plants

Prof. Stiles has tried to give in the present volume the present status of our knowledge in this branch and the possibilities of its future development. It will certainly create interest and stimulate further research.

B. K. K.

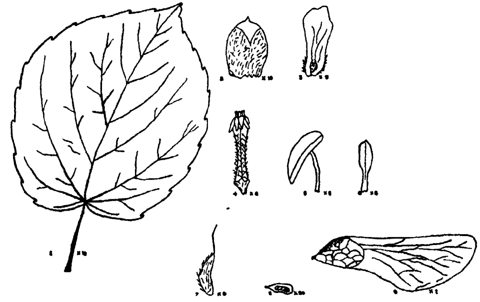
LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

MANSONIA DIPIKAE C. S. PURKAYASTHA *SP. NOV.* A NEW SPECIES FROM ASSAM*

Mansonia Dipikae C. S. Purkayastha *spec nov ; M. altissimae* A. chev proxissima sed ab ea inflorescentia minore, penduncul0 breviore, pedicellis longioribus (et basi pedicellorum glandula magna satis recedit) bracteis absentibus, foliis glabris. Vernacular name—*Badam* (Assamese) ; *lapse* (Nepali).

A large evergreen tree, attaining 25-35 M. in height and girth upto 3 M. *Bark* greyish white with longitudinal fissures , *Leaves* petioled, simple, softly tomentose with stellate hairs when young, but ultimately almost glabrous, 15-25 CM. long and 8-13 CM. broad, variable in shape—ovate-lanceolate, oblong or obovate-oblong, shortly acuminate, crenulate-denticulate, cordate at base, 5-7 nerves at the base with about 5 pairs of lateral nerves ; *Petiole* 3 5-3 CM. long. *Stipules* small, deciduous, *Inflorescence* a short panicle, terminal with the lower cymes axillary, densely tomentose with stellate hairs, 5-7 CM. long and as broad ; main rachis about 4 CM. long ; pedicels 7-13 MM long with a large gland at the base , bracts absent. *Flowers* about 2 CM. in diameter. *Calyx* spathaceous, unequally split at the tip, densely tomentose outside with stellate hairs, 12-13 MM. long. *Petals* 5, free, obovate, densely tomentose outside near the base, 15 MM. long, white with reddish tinge towards the base. *Androgynophore* 5-6 MM. long, tomentose ; *Stamens*—10 in 5 pairs, each pair alternating with a staminode ; anthers—filamented, about 2·5 MM. long, dorsifixed ; *staminodes* 5, linear-spathulate. *Ovary*—of 5 free carpels densely tomentose, styles linear ; Ovule—one in each carpel. *Ripe carpels* (1-5) of stellately spreading samaras, wings obliquely obovate-oblanceolate.



MANSONIA DIPIKAE C.S PURKAYASTHA.

Common in the Dhansiri Reserve of Nowgong and Rangapahar Reserve of Naga Hills District,

* *Mansonia Gagei* J. R. Drumm, is the first species described for the genus *Mansonia* (see *Jour. Linn. Soc.*, 37, 1905, p. 260). A. T. Gage (whose obituary we recorded in *Science and Culture*, November, 1946, p. 223) suggested that the Burmese *Kalamet* wood (source of perfumery) a new sterculiad and hence the species was named after him.
Ed *Sc & Cul.*

Altitude—500-700 ft Flowers, June-July Ripe fruits —October-November.

One fruiting specimen has been sent to the Herbarium, Lloyd Botanic Garden, Darjeeling another to the Herbarium, Forest Research Institute, Dehra Dun and the type specimen is in the Forest Herbarium, Shillong.

The species has some similarity with *Mansonia altissima* A Chev—known to occur only in West Africa, but the points of difference are —smaller inflorescence, shorter penduncle, longer pedicels, bracts absent, presence of a large gland at the base of the pedicels and glabrous leaf.

This is a good timber tree, with a durable heart wood and takes a good polish. The timber has been found suitable for boot last and is likely to prove a good timber for bobbin The following figures show the comparative strength of this species in relation to Teak (*Tectona grandis*)

Species	Weight per cubic ft lbs	Static Bending		Impact Bending		Hardness		
		Fibre stress at Elastic limit (lbs per sq in)	Modulus of elasticity (1000 lbs per sq in)	Fibre stress at elastic limit (lbs per sq in)	Modulus of elasticity (1000 lbs per sq in)	Radial (lbs per sq. in)	Tangential (lbs per sq in)	End. (lbs per sq in)
Teak (Air dry) (Burma & Malabar)	43	10,185	1,877	19,460	2434	1160	1145	1105
Mansonia Dipikae (Kiln dry)	42	10,815	1,853	21,585	2979	1350	1360	1360

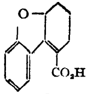
The author acknowledges with thanks the assistance given by Messrs M. B. Raizada and K A. Chowdhury of the Forest Research Institute, Dehra Dun, and Dr S. K. Mukherjee of the Royal Botanic Garden, Sibpur, who took considerable pains in the proper scrutiny and diagnosis of this new species. Thanks are also due to Mr V D. Limaya of the F.R.I. for carrying out the strength tests of this timber and supplying the necessary data which accompany this paper.

C. S. PURKAYASTHA

Office of the Working Plan Officer,
Shillong (Assam), 17-6-1946.

SYNTHETIC INVESTIGATION IN THE MORPHINE GROUP

FOLLOWING experiments have been carried out with a view to preparing hydrophenanthrene derivatives containing an oxide ring similar to that present in the Morphine skeleton



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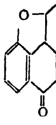

II

Sodio-derivative of ethyl phenoxymalonate was condensed with ethyl δ-bromovalerate in dry benzene solution, when ethyl α-phenoxy-α-carbethoxypimelate (b p. 200-206°/5 mm.; Found, C-63 1 per cent, H-7·4 per cent ; $C_{20}H_{28}O_7$ requires C-62·7 per cent, H-7·5 per cent) was obtained. This was hydrolysed by refluxing for a long time with concentrated hydrochloric acid and the resulting acidic product was esterified in the crude state by alcohol-sulphuric acid method to yield ethyl α-phenoxypimelate (176-179°/4·5 mm. ; Found, C-65 7 per cent, H-7 59 per cent ; $C_{17}H_{24}O_5$ requires C-66 2 per cent, H-7 78 per cent). Ethyl 6-phenoxycyclohexanone-2-carboxylate (b p. 166-169°/4 m.m. ; Found, C-68 5 per cent, H-7 3 per cent ; $C_{15}H_{18}O_4$ requires C-68·7 per cent, H-6 87 per cent) was obtained by refluxing ethyl α-phenoxypimelate in dry benzene solution in presence of sodium. A portion of this β-ketonic ester was treated with concentrated sulphuric acid in the cold according to the method of Bougault and the resulting product was hydrolysed The acidic fraction, which was expected to be (I) was obtained as a gum and could not be crystallised so far.

The potassio-derivative of ethyl 6-phenoxycyclohexanone-2-carboxylate was next condensed with ethyl bromoacetate by refluxing in toluene solution and the ethyl 6-phenoxy-2-carbethoxycyclohexanone-2-acetate (b.p. 190-195°/2 5 mm.; Found, C-65·3 per cent, H-6 96 per cent , $C_{19}H_{24}O_6$ requires C-65·5 per cent, H-6 9 per cent), thus obtained, was hydrolysed by refluxing with concentrated hydrochloric acid, when 6-phenoxycyclohexanone-2-acetic acid was obtained as a gum The dried gummy acid was treated with 84 per cent sulphuric acid first in the cold and then on a boiling water bath for a short time. The neutral product isolated, in the usual way, on once crystallisation from alcohol melted at 204-208° and was obtained in an extremely poor yield ; the expected structure of the compound being (II).

Further investigation in this line is in progress.

Thanks are due to Prof. P. C. Mitter for the interest he has taken during the progress of this work.

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15-10-1946.

LIFE CYCLES IN A POLLUTED RIVER

THE valuable and interesting article by Pillai and Subrahmanyan (*Science and Culture, 10*, 352) has caused me to look up old reprints and notes bearing on the far reaching subject of "Life Cycles in the Transformations of Organic Matter". In clearing up these old papers I have come across some notes taken long ago in the International Hygiene Exhibition in Dresden (1913 approx) to which the Rivers Department of the Manchester Corporation sent some exhibits illustrative of municipal sanitation Visiting the Exhibition "on deputation" I naturally took notes on items specially bearing on my official duties. As often happens, such old notes, if not immediately made use of, are apt to be "tidied away" and forgotten. It may be that the prominence of Nuremberg in the news has brought to mind some old lines of Longfellow which, quoting from memory, run somewhat as follows

"Where among broad meadow lands
In the valley of the Pegnitz
Nuremberg the ancient stands"

My old battered notes are entitled "Study of the Pegnitz" and were obviously carefully copied from the exhibits set out in the exhibition. They comprise a numbered list of organisms occurring before and after the discharge of Nuremberg sewage into the river, and in view of the apparent completeness of the list would seem to be worth while placing on permanent record for comparison with other analogous studies The list is as follows.

STUDY OF THE PEGNITZ

Pure Zone.—(1) *Simulium ornatum.* (2) *Chaetogaster diaphanus.* (3) *Sphemera vulgata.* (4) *Perla bicaudata.* (5) *Calopteryx virgo.* (6) *Gammarus pulex.* (7) *Gammarus fluviatilis.* (8) *Ancylus.* (9) *Pleurosigma formosum.* (10) *Synedra ulna* (Ehbg.). (11) *Striatella delicatula.* (12) *Metusore vaucnis* (13) *Potamogetom crispus.* (14) *Elodea.* (15) *Phragmites coni.* (16) *Myriophyllum spree.*

After Nuremberg.—(1) *Tubifex rivularum.* (2) *Nephatus vulgaris.* (3) *Vorticella merostoma.* (4) *Paramaecium caudatum* (Ehbg) (5) *Carchesium polypinum* (Kent). (6) *Chironomus plumosa.* (7) *Stylonychia mytilus* (O. F. Müll.). (8) *Stentor ranes.* (9) *Lionotus faesciola* (Ehbg).

Self-Purification.—(1) *Asellus aquatims.* (2) *Potamogeon pectinatus* (3) *Cyclops.* (4) *Potamogeton fluitans.*

In the same old note book I find the following jottings which may be of interest to the Director of Fisheries. They appear to be taken from the exhibit of the Konigl Inst. fur Binnen fischerei The following are copied verbatim·

"*Carchesium* shown to grow after *Sphaerostylus* C (?*Carchesium*) feeds on starch effluent. Also from sugar effluent"

"Sample of *Carchesium* from bottom of polluted stream after the surface water for 10 kilometres has become quite pure."

"*Vorticella* shows purified sewage"

"*Carchesium* occurs in distillery effluent with large dilution where formerly *Sphaerostylus* occurred"

The foregoing old observations confirm the results of the researches of the Bangalore workers, as well as the conclusions of the Howard school, that biological evidence is of greater value than purely chemical data in assessing the condition either of field or river.

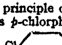
My thanks are due to Mr S. C. Pillai of the Indian Institute of Science and to Dr B. R. Seshachar of the Central College, Bangalore for having, so far as possible from literature available to them, checked up the list of organisms set out above and to the Director, Zoological Survey of India, Benares Cantt. for checking the list of zoological names.

GILBERT J. FOWLER

Central Hotel,
Bangalore, S. India,
26-10-1946.

STUDIES IN SULPHONES, PART III

SYNTHESIS OF NEW CONTACT INSECTICIDES

BUSVINE[1] in his note on "New Contact Insecticides" has mentioned that the active principle of the German insecticide "Lauseto Neu" is *p*-chlorphenyl-chlormethyl sulphone, m.p. 118°C. ClSO_2CH_2Cl. Although it is more toxic to lice and bed bugs than D.D.T. it suffers from the disadvantage

that its solubility in mineral oil is low. No details of the synthesis of this compound are yet available. Since this opens up fresh field for research on synthetic insecticides, it was thought worthwhile to prepare this and a few analogous compounds.

By reacting the sodium salt of *p*-acetamino-benzene-sulphinic acid with dichlor-acetic acid, *p*-acetamino-phenyl-chlormethyl sulphone (I), m p. 204-205°C , is obtained. This on hydrolysis gave *p*-amino-phenyl chlormethyl sulphone (II), m p 165°C. (decomp). The latter on diazotisation and further subjecting to Sandmeyer's reaction gave *p*-chlor-phenylchlormethyl sulphone (III), m.p 120°C., *p*-bromphenyl-chlormethyl-sulphone (IV), m.p 145-146°C and *p*-iodophenyl-chlormethyl sulphone (V), m.p 172°C On heating the diazonium solution of (II), *p*-hydroxyphenyl chlormethyl sulphone (VI), m p 144°C , was obtained. Compound (III) was also synthesised by the action of dichloracetic acid on *p*-chlorophenyl-sulphinic acid

Full details will be published elsewhere

B. C Jain
B. H. Iyer
P. C. Guha

Organic Chemistry Laboratories,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, 4-11-1946.

[1] Busvine, J R., *Nature, 158*, 22, 1946

STUDIES IN SULPHONES, PART IV. SOME SUBSTITUTED ALKYL-ARYL AND DI-ARYL SULPHONES

The recent discovery of Promin and Diasone, two therapeutically important members of the sulphone series, as antitubercular drugs, has stimulated work on the synthesis of new sulphones. In extension of our research work[1] in this direction, twenty new sulphones mentioned in the table have now been synthesised as detailed below.

By reacting the sodium salt of *p*-acetaminobenzene sulphinic acid (A) with propyl-, butyl-, isoamyl- and heptyl-halides as also with monochlor-acetone and picryl chloride, the respective *p*-acetamino-phenyl alkyl sulphones (I), (III), (V), (VII), (IX) and (XII) were obtained. They have been hydrolysed to the corresponding *p*-aminophenyl-alkyl-sulphones (II), (IV), (VI), (VIII), (X) and (XIII). *p*-acetamino-phenyl-β-hydroxyethyl-sulphone (XI) and *p*-acetaminophenyl-*p*-nitrobenzyl sulphone (XVIII) were prepared by the action of ethylene chlorhydrin and *p*-nitrobenzyl-bromide respectively on (A). These decomposed on hydrolysis.

By reacting (A), with *p*-benzoquinone and thymoquinone according to Hinsberg[2] compounds (XIV), (XV), (XVI) and (XVII) were obtained.

The action of deithyl-bromo-malonate on 4-nitro-4'-aminodiphenyl-sulphone gave (XIX) Compound (XX) was prepared by the fusion of the hydrochloride of 4-nitro-4'-aminodiphenyl-suplhone with dicyandiamide.

No		m p °C
I	AcNH C_6H_4 SO_2 $(CH_2)_2$ CH_3	135
II	NH_2 C_6H_4 SO_2 $(CH_2)_2$. CH_3	99-100
III	AcNH C_6H_4 SO_2 $(CH_2)_3$ CH_3	112
IV	H_2N C_6H_4 SO_2 $(CH_2)_3$ CH_3	93
V	AcNH C_6H_4 SO_2. $CH(CH_2\ CH_3)_2$	108-109
VI	H_2N C_6H_4 SO_2 $CH(CH_2\ CH_3)_2$	113-114
VII	AcNH C_6H_4 SO_2 $(CH_2)_6$ CH_3	99
VIII	H_2N C_6H_4 SO_2 $(CH_2)_6$ CH_3	97
IX.	AcNH C_6H_4 SO_2 CH_2 CO CH_3	115
X.	H_2N C_6H_4 SO_2 CH_2 CO CH_3	135
XI	AcNH C_6H_4 SO_2 CH_2 CH_2 OH	194-195 (decomp.)
XII	AcNH C_6H_4 SO_2 C_6H_2 $(NO_2)_3$ (2, 4, 6)	240 (decomp.)
XIII.	H_2N C_6H_4 SO_2 C_6H_2 $(NO_2)_3$ (2, 4, 6)	165 (decomp)
XIV.	AcNH C_6H_4 SO_2 C_6H_3 $(OH)_2$ (2, 5)	271-272
XV	NH_2 C_6H_4 SO_2 $C_6H_3(OH)$ (2, 5)	180
XVI	AcNH C_6H_4 SO_2 C_6H $(OH)_2$ (C_3H_7) (CH_3) (2, 5, 3, 6)	243-44 (decomp)
XVII	NH_2 C_6H_4 SO_2 C_6H $(OH)_2$ (C_3H_7) (CH_3) (2, 5, 3, 6)	234
XVIII	AcNH C_6H_4 SO_2 CH_2 C_6H_4 NO_2	270 (decomp)
XIX.	NO_2 C_6H_4 SO_2 C_6H_4 NH CH $(CO_2Et)_2$	144-145 (decomp)
XX.	NO_2 C_6H_4 SO_2 C_6H_4 NH C = NH NH C = NH NH_2	decomposes above 300°

The melting point of sulphone (IX) as reported by Walker[3] is 91-92°, whereas our observed melting point is 115° This compound was prepared by Walker's method also and on purification it gave melting point 115°.

B. C. Jain
B H. Iyer
P. C. Guha

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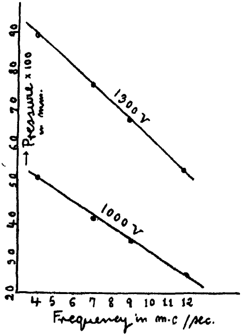
Dept of Pure and Applied Chemistry,
Indian Institute of Science,
Bangalore, 4-11-1946.

[1] Jain, Iyer and Guha, Science and Culture, *11*, 567, 1946.
[2] *Ber., 27*, 3259, 1894, *28*, 1315, 1895
[3] James Walker, *J. C S.*, 630, 1945.

CHANGE IN COLOUR OF HIGH FREQUENCY DISCHARGE THROUGH NITROGEN

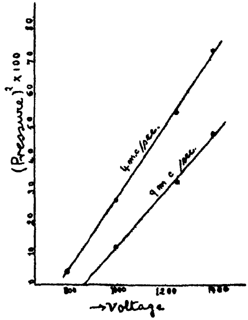
A number of observations have been recently made, showing the dependence of discharge colour and of the intensity distribution of the spectra of some gases, on the apparent frequency of the h.f oscillations as produced by a modified Hartley circuit.[1, 2, 3] In the case of nitrogen (air) the change of colour is accompanied by a change in the intensity distribution of the first and second positive nitrogen bands The energy of exciting electrons at which the change in colour is brought about seems to be of the order of 15 e v. which corresponds, under certain experimental conditions, to a frequency of 735 k.c /sec. If this electron velocity is reached only then the critical point namely the phenomenon of change of colour is also brought about



GRAPH 1

From the observations of Tawde and Mehta,[3] it is apparent that the lower the frequency of excitation oscillations, the higher the pressure of the gas needed to reach the critical point, also the greater the applied voltage the higher is the necessary pressure. According to Brasefield higher pressure corresponds to smaller electron velocity and also lower frequency means greater electron velocity. It appears that the two factors, pressure and frequency balance in such a manner that the required electron velocity is obtained ; similarly, higher voltage corresponding to greater electron velocity calls forth higher pressure to reach the critical point.

Incidentally, it is possible from their observations, to get some simple relations as are evident from Graphs 1 and 2. Graph 1 in which the critical pressure is plotted against frequency for two different voltages, shows that $P=mf+c$, where P is critical pressure, f the apparent frequency, m and c functions of voltage Similarly Graph 2 in which P^2 is plotted against applied voltage for two different frequencies shows that $P^2=m' V+c'$, where V is the applied voltage, P the critical pressure and m' and c' functions of the frequency



GRAPH 2

From Graph 2 it is seen that for 800 volts and 9 m.c/sec P^2 is a negative quantity This explains why Tawde and Mehta failed to observe the critical point in this case.

I wish to thank Dr R K. Asundi, Benares Hindu University, for valuable suggestions

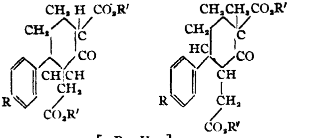
JAGDEO SINGH.

Balwant Rajput College,
Agra, 20-11-1946

1 R. K Asundi and J. Singh, *Proc. Ind. Acad Sc*, *22A*, 60, 1945 and references quoted therein
2 J Singh, *Curr. Sc.*, *15*, 20, 1946
3 N. R. Tawde and G. K. Mehta, *Proc. Ind Acad Sc.*, *23A*, 67, 1946.

SYNTHETIC INVESTIGATIONS ON SEXHORMONES

The following experiments have been carried out with a view to preparing phenanthrene derivatives which may prove useful for the synthesis of oestrone



$\left[\begin{array}{l} R = H \\ R' = Me \end{array}\right]$

I II

Ethyl γ-benzoyl butyrate was condensed with cyanoacetic ester according to Cope's modified technique[1] of Knoevenagel's Reaction to yield diethyl-α-cyano-β-phenyl-$\Delta\alpha\beta$ pimelate b p. 192-93°/3 5 mm. (Found. C, 68 0 ; H, 6 5 ; $C_{18}H_{21}O_4N$ requires, C, 68 5, H, 6 6) ; the resulting unsaturated cyanoester was reduced with aluminium amalgam in moist ethereal solution to the diethyl α-cyano-β-phenyl pimelate b p 205-215°/6 mm. (Found C, 67 5 , H, 7·4 , $C_{18}H_{23}O_4N$ requires C, 68 0 , H, 7·25) The sodio-derivative of the cyanoester was reacted with bromoacetic ester to furnish diethyl β-cyano β-carbethoxy-γ-phenyl suberate b p 225-35°/7 mm. (Found C, 66 25 ; H, 7 18 , $C_{22}H_{29}O_6N$ requires C, 66 5 ; H, 7 19) which on hydrolysis followed by esterification yielded dimethyl-β-carbomethoxy-γ-phenyl suberate b p 205-215°/7 mm (Found C, 64·98 ; H, 6 7 ; $C_{18}H_{24}O_6$ requires C, 64 3 ; H, 6 7) The tricarboxyllic ester underwent Dieckmann condensation on prolonged refluxing with sodium dust in benzene solution and the resulting cyclohexanone derivative (I) which could not be distilled without decomposition was converted on hydrolysis into 3-phenyl cyclohexanone-2-acetic acid m p 136-137° (Found: C, 72 26 ; H, 6 88 ; $C_{14}H_{16}O_3$ requires C, 72·4 ; H, 6·89 ; Semicarbazone m p. 192-93° ; Found: C, 61·53 ; H, 6 5 ; $C_{15}H_{19}N_3O$ requires C, 62·39 ; H, 6 56). This on Clemmensen's reduction yielded 2-phenyl cyclohexyl acetic acid m.p. 98-108° (Found: C, 76 82 ; H, 8 34 ; $C_{14}H_{18}O_2$ requires C, 77 5 ; H, 8·33). The Sodio-derivative of (I) was methylated to yield (II) b p. 180-184°/3 mm. (Found: C, 68·8 ; H, 6 9 , $C_{18}H_{22}O_5$ requires C, 68 o ; H, 6 9)

Our thanks are due to Dr P C. Mitter, Palit Professor of Chemistry (Retired) and Prof. S. N. Bose, Khaira Professor of Physics for their keen interest in this investigation.

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Calcutta, 10-12-1946.

APPLICATION OF CORRELATIONAL MATRIX IN PROBLEMS OF REGRESSION

In educational statistics we are often confronted with the following problem. Suppose there are n tests $x_1, x_2 \dots x_n$ in a battery. The problem is how to find out the best estimate of x_1 from a series of values for $x_2, x_3 \dots x_n$. With the help of Aitkin's method of "pivotal condensation" we can arrive at the solution very easily

Let the correlation matrix be denoted by

$$\begin{bmatrix} 1 & r_{12} & r_{13} & \dots & r_{1n} \\ r_{21} & r_{22} & r_{23} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ r_{n1} & r_{n2} & r_{n3} & \dots & r_{nn} \end{bmatrix}$$

where $r_{12}, r_{13} \dots$ are the total correlations

The method of finding the regression coefficients will be done in this way. Delete the criterion column in the matrix of correlations, transfer the criterion row in the bottom and the oblong matrix is written in the top left hand sheet of calculations.

Check column

A	$1 \; r_{23} \dots \dots r_{2n}$	$-1 \dots \dots$	$r_{23} + r_{24} + \dots + r_{2n}$
	$r_{32} \; 1 \dots \dots r_{3n}$	$. \; -1 \dots \dots$	$r_{32} + r_{34} + \dots + r_{3n}$
	$\dots \dots$	$. \; . \; -1 \dots$	$\dots \dots$
	$r_{12} \; r_{13} \dots \dots r_{1n}$	$\dots \dots$	$r_{12} + r_{13} + \dots + r_{1n}$
B	$1 - r_{23}^2 \dots \dots r_{3n} - r_{32}r_{2n}$	$r_{32} \dots \dots$	$1 - r_{23}^2 + \dots + r_3 - r_{32} \; r_2 + r_{32}$
	$r_{43} - r_{42}r_{23} \dots \dots r_{4n} - r_{42}r_{2n}$	$\dots \dots$	$\dots \dots$
	$\dots \dots$	$\dots \dots$	$\dots \dots$
	$r_{13} - r_{12}r_{23} \dots \dots r_{1n} - r_{12}r_{2n}$	$\dots \dots$	$\dots \dots$
	$\dots \dots$	$\dots \dots$	$\dots \dots$

A middle block of columns of the same number is ruled on the right of the oblong matrix of correlation coefficients on the right of all a check column The columns of the middle block are filled with a pattern of minus ones diagonally as shown leaving the other cells empty including the bottom row In the check column is given the sum of each row Slab B of the calculation is then formed from slab A by writing down in order as they come, all the tetrad-differences of which the pivot in A is one corner By tetrad-differences we mean the difference of the products of correlation co-efficients. We proceed slab after slab, until no number remain in the left hand block The final expressions obtained in the middle block give the values of regression coefficient

The above procedure will be clear when we consider the case $n=3$ Following the above method, the calculation chart may be written as

A	1	r_{23}	-1	0	r_{23}
	r_{32}	1	0	-1	r_{32}
	r_{12}	r_{13}	0	0	$r_{12}+r_{13}$
	$1-$	r_{23}^2	r_{12}	-1	$r_{32}-r_{23}^2$
B	$1\ 00$		$r_{32}/1-r_{23}^2,$	$-\dfrac{1}{1-r_{23}^2}$	$r_{23}/1+r_{23}$
	$r_{13}-r_{23}\,r_{12}$		r_{12}	0	$r_{12}+r_{13}-r_{12}\,r_{23}$
			$r_{12}-\dfrac{r_{13}\,r_{23}-r_{12}\,r_{23}^2}{1-r_{23}^2}$	$,\dfrac{r_{13}-r_{12}\,r_{13}}{1-r_{23}^2}$	$(r_{12}+r_{13})-r_{12}\,r_{23}-\dfrac{r_{23}(r_{13}-r_{12}\,r_{23})}{1+r_{23}}$

For this case the regression co-efficients are $r_{12}-\dfrac{r_{13}\,r_{23}-r_{12}\,r_{23}^2}{1+r_{23}}$ and $\dfrac{r_{13}-r_{12}\,r_{23}}{1-r_{23}^2}$. If we proceed in the usual way we shall obtain the same expressions

When the number of tests in the battery exceed four the calculation of the regression coefficients by this method will be simplest. A full paper, applying this method will be published shortly.

PURNENDU KUMAR BOSE

Calcutta Statistical Association,
Calcutta, 16-12-1946.

COMPOUNDS OF THIOUREA WITH BIVALENT METALS

SEVERAL compounds of thiourea with bivalent metals have been described by Walter and co-workers[1], these workers have described two compounds of thiourea with cadmium chloride *viz* $2CdCl_2$, 5Thio and $CdCl_2$,2Thio [Thio standing for one molecule of $CS(NH_2)_2$]

We have however found that the thermometric titration of $CdCl_2$ solution with thiourea solution gives three inflexion points corresponding to $CdCl_2$, 2Thio, $CdCl_2$,4Thio, and $CdCl_2$,6Thio Freezing point experiments with $CdCl_2$ solutions containing varying amounts of thiourea have also been undertaken with a view to find out the state of dissociation of the above mentioned compounds.

40 c c of a 0 2146 molar solution of $CdCl_2$ was titrated thermometrically with a 2 022 molar solution of thiourea, the titration curve shows three distinct breaks corresponding to the additions of 9 1 c c, 18 0 c c and 27 0 c c of the above thiourea solution. Molecular ratios of cadmium chloride thiourea for the first, second and third breaks are respectively 1 2 14, 1.4 24 and 1.6 36, the proportion of thiourea being in each case 6-7 per cent higher than that required by the formulae $Cdcl_2$,2Thio, $CdCl_2$, 4Thio, and $CdCl_2$,6Thio. This signifies that each of the three thiourea compounds of cadmium dissociates, to some extent, in concentration between M/5 and M/10 and the formation of each compound at such concentration is complete only if the thiourea present be 6-7 per cent in excess over the required stoichiometric proportion

Thermometric titrations of solutions containing chlorides of other bivalent metals with thiourea are in progress.

My grateful thanks are due to Prof. Priyadaranjan Rây, M A., F.N.I., Palit Professor of

Chemistry, University College of Science and Technology, Calcutta, who has kindly suggested the problem to me.

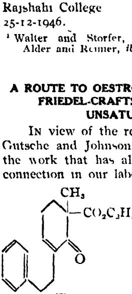
SUSHIL KUMAR SIDDHANTA

Chemical Laboratory,
Rajshahi College
25-12-1946.

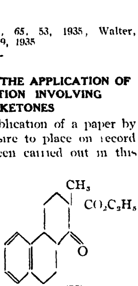
[1] Walter and Storfer, *Monatsh*, 65, 53, 1935, Walter, Alder and Rcimer, *ibid*, 65, 59, 1935

A ROUTE TO OESTRONE BY THE APPLICATION OF FRIEDEL-CRAFTS REACTION INVOLVING UNSATURATED KETONES

IN view of the recent publication of a paper by Gutsche and Johnson[1] we desire to place on record the work that has already been carried out in this connection in our laboratory



(I)



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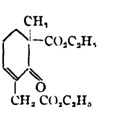
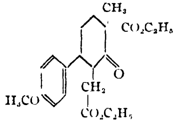


(III)



(IV)

Phenyl ethyl bromide was condensed with potassio derivative of ethyl cyclohexanone carboxylate and the resulting substituted β-keto ester was opened up to diethyl α-(β-phenyl ethyl)-pimelate, b p 184°/2 5 mm (Found. C, 71 59, H, 8 80; $C_{19}H_{28}O_4$ requires C, 71 24, H, 8 75) with calculated quantity of alcohol and 0 2 mole of sodium This excellent condition was introduced in our laboratory by the late K C. Ghosh while he was engaged with the problem of synthesising Wieland's tricarboxylic acid The diester was cyclised with sodium dust and benzene by heating for a short time on the water bath and methylated *in situ* to furnish 2-(β-phenyl ethyl)-6-methyl-6-carbethoxy-cyclohexanone, b p 165°-170°/3 mm (Found. C, 75·72, H, 8 03, $C_{18}H_{24}O_3$ requires C, 75 00, H, 8 3). The above compound was brominated either in ethereal or carbon tetrachloride solution and a molecule of hydrogen bromide was split up by heating with dimethylaniline at 180-195° for one hour and a half The unsaturated cyclohexanone derivative (I); b p. 165-170°/2 mm. (Found C, 76 1; H, 7·1; $C_{18}H_{22}O_3$ requires C, 75 52, H, 7·6) was cyclised following the method of L. I. Smith[2] and heated on the steam bath for a short time after removal of the solvent to furnish a slightly reddish compound (II), b p 165°/3 mm (Found C, 76 3; H, 8 3, $C_{18}H_{22}O_3$ requires C, 75 52; H, 7 6). The ultraviolet absorption spectra of the compounds (I) and (II) were observed and the curves were found to be different. P-Methoxy phenylethyl iodide was condensed with potassio derivative of ethyl cyclohexanone carboxylate to yield 2-(p-methoxy-β-phenylethyl) 2-carbethoxy-cyclohexanone, b.p 195°/4 mm (Found C, 70 5, H, 7 77, $C_{18}H_{24}O_4$ requires C, 71 05; H, 7 89)

Ethyl cyclohexanone-6-carbethoxy-2-acetate was prepared according to the method of Chatterjee[3] and was methylated in the usual way, b p 150°/5 mm The above compound was brominated in the usual manner and a molecule of hydrogen bromide was split up in the above way to yield (III), b p 158°/4 mm (Found C, 62 15, H, 7 6, $C_{14}H_{20}O$, requires C, 62 68, H, 7 46) The Friedel-Crafts reaction between (III) and anisole was carried out as follows to a mixture of anisole (20 c c) and (III, 6 5 g) was added aluminium chloride (8 g) in small portions by shaking and cooling at room temperature The thick mass thus obtained was saturated in cold with dry hydrogen chloride and heated at 50°C for one hour Next it was cooled and again saturated with dry hydrogen chloride and heated for about one hour During the heating the temperature rose to 80° The reaction mixture was worked up in the usual way and washed with alkali and distilled to obtain (IV), b p. 195°/1 5 mm (Found C, 67 52, H, 7 44, $C_{21}H_{28}O_6$ requires C, 67 02; H, 7 45) In view of the works of Ghosh[4] and Cook et al[5] the compound (IV) is being investigated and its final conversion to oestrone is in progress

Our sincere and grateful thanks are due to Dr P C Mitter, Palit Professor of Chemistry (Retired) for the keen interest and to Prof Dr D K Banerjee of the College of Engineering and Technology, Bengal for his valuable advice and encouragement during the course of this investigation

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Calcutta, 30-12-1946

[1] *J. A C S.*, 68, 2239, 1946.
[2] *Ibid*, 62, 77, 1940, 64, 202, 1943
[3] *J Ind Chem Soc*, 163, 1939
[4] SCIENCE AND CULTURE, 3, 56 and 102, 1937.
[5] *J Chem Soc*, 1559, 1937.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. MARCH, 1947 No. 9

SCIENCE AND INDUSTRIAL PRODUCTION

THE Trade Union Congress* of U K , which met recently at Brighton, from Nov 21 to Nov 25 held important discussions on various issues, one of the most important being on production Mr Skilbeck of the Amalgamated Society of Woodworkers, proposed that,

> " Congress declares that in the best interests of raising national productivity so that the standard of living of the people can be improved, it is necessary for the Trade Union Movement to give attention to the whole problem of applying the most modern scientific and technological developments throughout industry in order to lighten the burden of labour and to remove the obstacles to productivity represented by out-of-date methods often serving only vested interests among employers "

The above resolution raises two problems before the Indian readers who are not conversant either with the condition of industry in Great Britain or role of Trade Union Movement there To begin with the second, T.U. movement is still largely restricted to the working class ; in fact, the government do not allow the members of staff (the gentlemen !) to join any T U of the workers, the former must have their own T.U if it is to be recognized by the authorities The response to the call given by the T.U.C during the war to increase production and the rise of the Joint Production Committees in which workers sat side by side with the employers, solving their industrial problems and working out more efficient methods, brought about a qualitative change in the T U movement in Great Britain "The Labour movement was able to insist that none of the major problems of labour and production should be solved without their direct participation It is not suggested for one moment that the employing class welcomed such participation Quite to the contrary But they were forced to accept what was to them an unpleasant reminder of the strength and influence of the working-class movement "[1]

With regard to the first question, it is a common misconception here in India that each and every scientific innovation is put into practice As a matter of fact, the above resolution might mean a bit superfluous to many of the readers Let them remember that most of the looms in Lancashire today are operated by steam energy instead of by electricity in spite of the fact that use of the latter not only would be hygienic and economic but would raise the production considerably It would be worthwhile to consider this problem in detail.

The principle of electro-magnetic induction was discovered by Faraday in 1831 and the same year the first dynamo was built by him , but it was only after fifty years that the first public supply station was constructed. Though Faraday and others clearly foresaw, the potentialities of the discovery, the well-known story of Gladstone and Faraday shows that the politician would not, or did not, help research to bring the discovery to the service of the people in a short time. D.D.T. has been known to chemistry since 1873 but only in 1939 was it taken seriously into consideration Prior to the time when Geigy Chemical Company in Switzerland took to financing further researches on this chemical compound, two other insecticides—pyrethrum and rotenone—were the best 'insect killers'. To the manufacturers these

* "It was the biggest Congress ever held" was the opinion of the *Scientific Worker*, about the last Trade Union Congress, the mouthpiece of the Association of Scientific Workers in Great Britain "793 delegates attended representing 192 affiliated unions, the membership of Congress is now 6,671,120 an increase over last year of 95,466. Particularly noteworthy was the attendance, for the first time since 1927, of the Civil Service unions, now able to participate after the repeal of the Trades Dispute Act." . . . . The Association of Scientific Workers was represented by its President Professor Blackett and three others.

[1] "British Workers in Action" by John Stammers.

chemicals paid well and D D T had to wait for a World War to come into its own [2]

There are other examples We are now hearing of the coal-crisis in the U K In the Tory papers, this is being ascribed to the inefficiency and amateurishness of the first Labour Government But it is a matter of common knowledge that the crisis is partly due to the fact that British coal mining methods are all antiquated, and for the last twenty years, the owners of coal mines have opposed all measures at introduction of modern methods

For researches in matters scientific—be they in peace or in war, academic institutions or industrial establishments—adequate finance is a matter of prime importance But who is going to finance and why? The academic institutions are the only of the kind which take interest in research for the sake of advancement of knowledge The governments of all countries (excluding U S S R) have been found to take extraordinary interest only when the researches contemplated held out some promise that they would help in winning the war.[3] *The Times* wrote in its editorial on the 1st November, 1943, " . It is estimated that existing research associations have a total income of £800,000 to £1,000,000 a year, which includes £200,000 from the Government This is niggerdly on both sides " It may be pointed out by way of comparison that the same year the first B-29 bomber which came out of the plant cost £785,000 each!

The largest amount of money for research is provided by industrial concerns "It is, however, not competitive but monopolistic industry which now controls the main applications of science . Indeed, at the present moment in Britain, probably four-fifths of the industrial research, outside that carried on by the Government, is undertaken by no more than ten large firms In Germany, the position was further developed, and the research laboratories of large industrial combines such as I G. Farben Industrie, the A. E. G or the Siemens-werke became more important centres of research than even Government or university institutions "[4] It is needless to add that the patronage of such monopoly concerns on researches is not motivated by cultural considerations. Science entered the field of industry for improving the quality of goods But, as we shall see, it is industry which to a large extent now controls science. However, it is quantity of goods far more than its quality that concerns an industrialist in the utilization of scientific means If production can be doubled or trebled *without entailing a large scale changes in the plants* so far so good, and the manufacturer hastens to see ways and means for 'pushing the sale"[5]. And, if scientific innovations seem to threaten plants with obsolescence and demand a fresh heavy outlay, there begins the stifling of researches by the monopolists' financial machinery This point has been forcibly brought about by Sir Alexander Gibbs in his presidential address to the Engineering Section of the British Association (1937)

"Of course here, as always in research it is the case that the greater the success of research, the more immediate and drastic the effect on existing plant and equipment That is where the rub sometimes lies Millions are necessarily sunk in fixed assets, which may in a year or two be made obsolete by the development of new methods Obsolescence is indeed so rapid now-a-days that it is not unusual for new plant to be written off in four years, and many valuable inventions have been brought up by vested interests and suppressed in order to save the greater loss that their exploitation would involve to already operating plant It is therefore not surprising that there is not always an enthusiasm for unrestricted research or a readiness to praise it"

Far from praising such efforts innumerable instances could be brought forth to show how the industrialists stifle researches Professor Bernal cites[4] a valuable instance of the failure until comparatively recently to develop research into aluminium and other light metals In 1939, he remarked:

"The production of these metals is in the hands of rigid monopolies concerned with keeping a high price on a relatively low output At that price aluminium cannot compete successfully with steel for many articles, *e g*, motor cars, in which its use would be more appropriate As research designed drastically to lower the price of aluminium would probably result in its production from low-grade materials such as clay, without involving as at present the use of electric power in large quantities, the results of improvement would be sooner or later to break the monopoly Consequently such research has not been encouraged"

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[2] Sir John Anderson, F R S in his statement of the 7-8-45 on the release of the first atomic bomb said "Scientists have solved a problem in 4 years which in peace time might have taken up to 50 years"

[3] The atomic bomb which is the product of Anglo-American collaboration when touched the grounds of Hiroshima found Mr Truman boastingly announcing, "We have spent $2,000,000,000 (about £500,000,000) on the greatest gamble in history and we have won"! It is reported that at one time of this project 125,000 persons were engaged in its production.

[4] "The Social Functions of Science" by J D Bernal (1939), pp. 138.

[5] It is customary among the manufacturers in the U S A to allot 50% of the total annual expenses for advertisement alone Estimated cost on advertisement in the U S. A per year is $2,000,000,000 the same as spent on atomic researches! (See Practical Psychology by F F Berrien)

Prof. Bernal states that "it is known that press advertisement alone accounts for an annual expenditure of £35,000,000" in Great Britain. "The press advertisement of patent medicines alone . amounts to £2,800,000 more than is spent by the Government and Industry combined on scientific research."

Another notable example, as shown by the same author,

"is the relative slowness with which electric gas-tube lighting has been developed Any really effective general use of this method of illumination would have the effect not only of reducing to one-third or one-quarter the demand for electric energy for the same degree of illumination, but also of rendering useless to a large extent the capital sunk in production of ordinary electric light bulbs Only when large new demands for cheap illumination appears, such as those introduced by modern street lighting plans or display illumination of buildings, is the problem of developing electric gas lighting seriously taken up With a relatively small expenditure on research the achievements of today would have been reached twenty or thirty years ago and we would now be that amount ahead"*

Monopoly in researches is taking a still graver form as is witnessed in the secrecy observed in atomic researches. Might this secrecy in particular not develop into secrecy in researches in general, is a pertinent question to ask Where would science lead to if researches leading to radar, D D T or sulpha drugs were guarded as close secrets by Governments or industrial combines

It may not be out of place to add a word of caution regarding industrial conditions existing in India Uptil recently only the British vested interests stood against any improvement or expansion in our industries But it now seems that two devils would share the stage. "There is one danger which should be guarded against an unholy alliance between Indian and Anglo-American capitalists" These are not the words of any "Red" but of the sober and level headed scientist Sir J C Ghosh in a lecture given recently under the auscipes of the Indian Science Congress and as reported in the editorial of the last issue of this journal It would be worthwhile to quote a few illustrations

The Hindusthan Aircraft Company was allowed by the Government of India to be set up in 1940 after a tremendous hue and cry raised against the obstacles put forth by the late bureaucratic Government and over which issue the Diwan of a large State had to resign As soon as the din subsided, the Government bought up quietly the majority of shares in it and put it in charge of the Supply Department Thereafter the plant was turned into mere repair shop for the U. S Air Forces in India till 1945 When the war was over, the Government of India thought of using the plant for making wagons (?) for railways. Subsequently popular pressure compelled the Government to allocate funds for re-establishing it as an aircraft manufacturing concern. The Government grudgingly agreed to pay for this purpose Rs. 13 lacs to be spent over 5 years! The *Eastern Economist* revealed last June that out of the three full time directors of this firm only the finance-director would be Indian, the rest two to be brought from England

Many of us must have been familiar with the advertisements appearing in the papers heralding the 'Hindusthan 10' as 'India's Own Car' But after 18 months of the existence of this firm, Mr B M. Birla, the Chairman, confessed at a recent Annual General Meeting that 'even the assembly of parts had not begun and the cars were being bodily imported from England'.

These two illustrations prove that no serious step is being taken in India for the manufacture of automobiles, even by Indian capitalists Contrast with this the earnestness of the U S S R in 1925 when whole American plants were bodily transferred to Gorky and other cities for the manufacture of automobiles and these factories began supplying the full demands of the country for peace as well as war-purpose

On the other hand such industries which existed before are now evincing a doubtful future The Mathematical Instruments Office (M.I.O) in Calcutta has been producing for over a century of its existence, ordinary survey instruments In a dynamic world the M I O remained a static body on the hackneyed plea that neither the climatic conditions were suitable for manufacturing high grade optical instruments nor were available requisite technical personnel. The pressure of the war blew away all the myths, and the M I O during the last war manufactured about 20,000 prismatic binoculars, over 1,200 telescopes and a host of other precision instruments. The personnel jumped from the pre-war 341 to 2115. Barely the guns have ceased firing and the personnel has already been halved In June last the Aeronautical Section of the M I O was paralyzed by the retrenchment of its personnel of 150 , and now it has been sold over to the Orient Airways on the plea that it served no other purpose than that of a godown It is now not uncommon to see orders for goods which used to be manufactured in the M.I O now finding their way to foreign firms. Thus the hopes of expanding the activities of the M I.O. into a large scientific instrument manufacturing concern are being shattered under the very nose of the first National Government!

That the resolution of the Trade Union Congress on production was a matter of dire necessity is justified by the caution given by Professor Bernal in one of his addresses:

"When the scientist allows himself to be used without concerning himself with the results of his work, he is handing things over not necessarily to people who have base or anti-social' motives but to people who are just plainly incompetent, who do not know what they are doing, so that the chance that they do anything particularly good is remarkably small"

* "Social Functions of Science," pp. 143

ROYAL BOTANIC GARDENS, KEW

D. CHATTERJEE,

ASSISTANT FOR INDIA, ROYAL BOTANIC GARDENS, KEW

THE Royal Botanic Gardens, Kew are situated about nine miles south west of the city of London on the bank of the Thames. They are the headquarters of intensive botanical research for all the countries now under the British Government. The early history of Kew Gardens dates back towards the latter half of the seventeenth century when a part of the present area belonged to one Lord Chapel. After his death in 1696 the property came in the hands of his grand niece Lady Elizabeth Chapel daughter of the second Earl of Essex Her husband was a bit of an astronomer and he converted part of the Kew House into an observatory and erected a telescope there In 1725 the Astronomer Royal, Dr Bradley made two important discoveries here *viz*, (*i*) the aberration of light, and (*ii*) the nutation of the earth's axis In 1730 Lady Elizabeth died and the property was leased to Frederick, Prince of Wales Thus was inaugurated the long and intimate association of Kew with the Royal family

Frederick took an interest in the improvement of the garden but died prematurely in 1751 and his widow Princess Augusta of Saxa-Gotha, mother of George III took charge of improving the garden In 1759 with Earl of Bute as scientific director, William Aiton as head gardener and Sir William Chambers as architect she made a garden of some fifteen acres. It is to this lady that credit is also due for making this a Botanic Garden (by growing plants of academic interest) as it is understood, apart from an ordinary flower garden. Her architect built a number of temples and buildings but some of them ran into decay and were later demolished A few of his substantially built structures still remain such as the Pagoda (built 1762), Temple of Aeolus (1760 but rebuilt in 1845), Temple of Bellona (1760) and the Orangery (1761)—now one of the museums Princess Augusta died in 1772 and her garden came in the hands of H. M. George III. He purchased the hitherto leasehold property from the Essex family and extended the area by joining it with another neighbouring property on the Richmond side which he owned. He secured the service of Sir Joseph Banks, the then President of the Royal Society and one of the most famous scientific men of his time. Sir Joseph was the first unpaid Director of the garden which post he held until his death in 1820. One of the most notable events of Sir Joseph's regime was the sending of plant collectors abroad. They were well known men like Francis Mason (collected in South Africa) and Richard Oldham (collected in China and died there in Amoy) George III and Sir Joseph Banks both died in 1820 and after their death the garden deteriorated in efficiency and repute. A period of stagnation followed and during the early years of Queen Victoria's reign the idea of abolishing the botanic garden was taken up seriously Public opinion was strongly expressed against this idea and the garden (hitherto a property of the Royal family after its purchase by George III) was given to the Nation by the Queen in 1840.

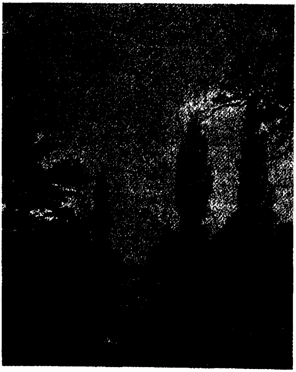

FIG. 1. The Pond

This historical background and the early association of Kew Garden with the Royal family is admirably outlined by an ex-director in the following words.—

"Outside the Metropolis (*i.e.* London) there is probably no spot which has seen so much of our history as the piece of ground included within the bend of the Thames which lies between Kew and Richmond bridges. Successive dynasties made it their residence. Henry VII built the palace in Richmond in which his successor entertained the Emperor Charles V Queen Mary lived there and in it Elizabeth signed the death warrant of Mary Queen of Scots, and died herself. In Kew in Ormond Lodge, George II

gave Sir Robert Walpole a rough reception when he was roused to hear of his accession to the throne and it was in the adjoining garden that Sir Walter Scott placed the interview of Jeanie Deans with Queen Caroline one of the most capable of Queens. At Kew itself was the residence of George III and his mother Here he gave Lord Bute his dismissal, his children were brought up and two of his sons William IV and the Duke of Kent were married in the presence of the dying Queen Charlotte. The impress of history remains on Kew. In its main features it still remains as George III left it The Royal influence and atmosphere persists It is now the stately garden of a great personage, though that is now the British people and no longer the Sovereign In truth it possesses the grand manner which can be inherited but not acquired "

houses were presented to the Gardens by well wishers.

The Herbarium

Although a herbarium is indispensable to the proper working of a modern botanic garden it was not started till the year 1853 Owing to the absence of such a herbarium some of the early collections from India and other parts were distributed to other institutions in the United Kingdom and Europe. The Herbarium and its necessary adjunct, a botanical

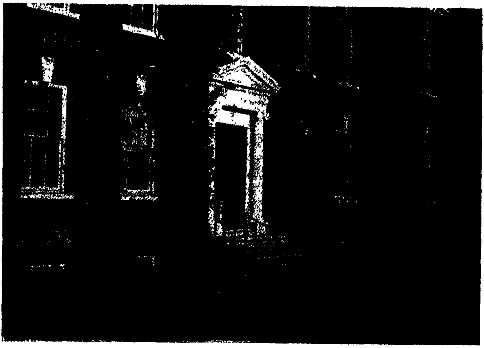

FIG. 2 Entrance to the famous Kew Herbarium The creeper on the wall is *Magnolia Grandiflora* which is known to be an erect small tree It had to change its normal habit in the hands of the *Kew* staff

library are very important departments by whose constant help the identity of plants whose names are unknown or lost could be ascertained In Kew where thousands of species from all parts of the world are in actual cultivation (45,000 species excluding horticultural varieties) the botanists in the Herbarium are kept constantly busy naming and identifying plants living or dead It was first started with a small personal collection of Sir William Hooker at the Hanover House, the residence of the late Duke of Cumberland. It soon grew by leaps and bounds and now occupies three large extensions of the original Hanover House. These extensions are now known as A (four storied) B, and C (three storied) Wings. The present total of herbarium sheets now

In 1841 the garden started as a national property. Sir William Hooker, then Professor of Botany at Glasgow was appointed the director. With him a second period of activity was started. He threw open the garden to the public and during the first year there were 9174 visitors. Some 45 acres of land was added in 1843 and by subsequent addition in 1845 and later, the present area of 288 acres was found. The palm house was constructed in 1848, a lake was excavated and made in 1861, the temperate house and the rock garden were made in 1862 and 1882 respectively. Recently in 1930 the rock garden was further enlarged. A second cactus house was built in 1932, and shortly afterwards a house for South African succulent plants was added. Both these

extend over six millions and the library contains some sixty thousand volumes. The number of different journals received are 600 and in most cases complete sets from beginning are available at Kew It is in this herbarium that intensive botanical researches were made by so many well known botanists and a number of floras and standard publications were prepared A list of some of these books would be as follows —

Flora of West Indies (1859—64), Flora of Hong Kong (1861), Flora of Australia (1863—78), Flora of Tasmania (1855—59), Flora of New Zealand (1864—67), Flora of Mauritius and Seychelles (1877), Flora of British India (1872—97), Flora of Ceylon (1893—1900), Flora Indica-Hooker et Thoms (1855), Flora of Tropical Africa (1868—98), Niger Flora (1849), British Flora (1858), Flora capensis (1859- 1900), Flora of Bombay (1901--1903), Flora of Upper Gangetic Plain (1905--1929), Flora of Madras (1915—1936), Botany of Bihar and Orissa (1921 -1925), Flora Braziliensis (1840—1906), Handbook of Fern allies (1877), Monograph on Sorghum-Snowden (1936), Families of Flowering Plants—Hutchinson I (1926), II (1934), Flora of West Tropical Africa (1927—1936), Genera Plantarum (1862—1883), Index Kewensis (1895—till continuing), Botanical Magazine (Edited from Kew) (1787—still continuing)—the oldest botanical journal still running, Kew Bulletin (1887 -still continuing), Hooker's Icones Plantarum (1836—still continuing.)

The herbarium is laid out on the general plan of Bentham and Hooker's *Genera Plantarum* and each genus containing dried plants from any part of the world is allotted to eighteen marked bundles according to the source Some of the widely distributed plants of hydrophytes may be found occupying each bundle of such a genus This geographical plan is as follows and the regions are under the charge of botanists as indicated below The botanist is responsible generally for the identification of all plants coming to Kew from these regions and also for critical studies of special groups. There are however some specialists in some groups who deal with all plants belonging to their particular line of studies The present staff (1946) of the Herbarium is given below.

Sir Edward J. Salisbury, C B E, F.R.S. (Director), Dr W. B Turrill (Keeper of the Kew Herbarium and Library)

1	Europe	B L Burtt
2.	North Africa and Orient	R A Blakelock
3	Northern Asia	J R Sealy
4	China and Japan	
5	India	D Chatterjee
6.	Malay Peninsula and Malasian Archipelago	H K Airy Shaw
7.	Australia	V S Summerhayes
8.	New Zealand	
9.	Polynesia	
10.	Tropical Africa	E Milne-Redhead
11	Mascarene Islands	(Miss) E A Bruce
12.	South Africa	
13	North America	A A Bullock
14.	Central America	
15.	East Tropical South America	N. Y. Sandwith
16	W. Tropical South America	
17	Temperate South America	

Specialists	—Orchidaceae	—V. S Summerhayes
	Gramineae	—C. E Hubbard
	Cyperaceae (Specially *Carex*)	—E Nelmes
	Ferns and Fern Allies	—F Ballard
	Algae and Bryophytes	—(Miss) C I Dickinson
	Fungi	—(Miss) E M Wakefield
		R. W G Dennis
		P H B Talbot (Botanist for S Africa)

The above list does not include the staff of the Director's Office, Library, Herbarium Office, Museums, Garden Curator's Office and the Jordell Laboratory

Besides the academic work of taxonomy, Kew had played a very important role in the past for introducing plants of horticultural and economic value The African *Pelargoniums* (commonly called "garden Geranium"), *Cinerarias*, the Chilian "Monkey Puzzle" (*Araucaria*), the Douglas Fir, *Rhododendrons*, *Gentianas*, *Primulas*, *Bougainvillea* and many other garden plants have been introduced and acclimatized by Kew.

KEW DURING WORLD WAR II

Kew played an important role during World War II Most of the student gardeners and members of the staff were called up and the Gardens continued with a small skeleton staff Student gardeners were soon replaced by women gardeners The question of transferring the herbarium to a place of safety engaged the attention of the Director and after the bombing of a part of the British Museum of Natural History in 1940, prompt action had to be taken. Those parts of the Herbarium in which the specimens were housed in wooden cabinets were transferred, half to Oxford and half to a place in Gloucestershire. The Museums did not suffer any major damage although some valuable paintings had to be removed. Shortage of labour was evident and greatly handicapped the re-arrangement of the evacuated herbarium cabinets. What seemed to be an impossible task was achieved by the so called "exiled" members of the staff who went to Oxford. Their early days at Oxford are described by themselves in a joint letter to their headquarters as follows:

"We have had our adventures The installation of the six hundred cabinets involved a good deal of carpentry and much of the work fell, literally, on our shoulders The heaving about of cabinets involved the use of muscles almost atrophied by long disuse The hand that formerly wielded a dissecting needle now twiddled a screwdriver. Aches and pains developed frequently in strange places, but the job was eventually finished and we were able to devote our attention once more to strictly botanical work. It is fortunate that we are all old soldiers and have no false pride"

The years 1941 and 1944 were particularly bad for Kew. Several high explosive bombs, oil bombs, delayed action bombs, missiles and hundreds of incendiaries fell within the gardens. The blasts broke the glass panes of nurseries, Herbarium windows and the Temperate House, and for a few days in the 1944 Blitz the Gardens had to be closed to the public for removing five unexploded bombs. Once a few incendiaries fell on the roof of the Herbarium, but fortunately they did not burst into flames The centenary of Kew Gardens as a national institute fell in 1941 but owing to the conditions of war this could not be celebrated in a fitting manner. Another very unfortunate event of this year was the sad and tragic death of the Director (the late Sir Arthur Hill) on 3rd November 1941 in a riding accident.

some. The elder pith which was for a long time imported from the Continent and used in delicate electrical instruments was in high demand and through the scientific assistance of Kew a small factory was established for this The cessation of fruit import and shortage of fruit juices supplying vitamin C in the diet of infants was keenly felt A substitute was suggested by Kew and syrups made from rose hips supplied a good alternative source of Vitamin C Experiments were made at Kew with a view to obtaining an *agar* substitute from certain native seaweeds—agar being normally obtained mainly from Japan A fuller investigation was undertaken later by one of the Marine Biological Stations which resulted in the commercial preparation of a British agar suitable for bacteriological work Other activities

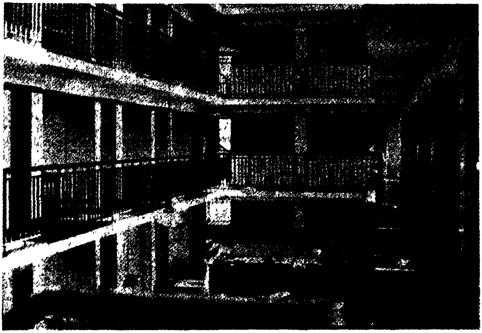

FIG. 3. Interior of the Kew Herbarium (Wing A)

in connection with camouflage work were undertaken by the Kew staff and the details and the results achieved will perhaps be published soon. The Herbarium was brought back to its original home toward the end of 1945 and is now almost ready for normal work.

Considering the damage suffered by Greater London it is pleasing to record that the damage to Kew and its historic buildings is almost negligible Botanists all over the world anxiously watched and prayed for the safety of Kew, and after the years of war, it may be said that this fond and wishful thinking has been really achieved.

Kew was also a popular place nearer home to Londoners for relaxation during War, as restriction on long distance travel did not allow people to go very far. Open spaces of the gardens were devoted to vegetable growing as was also done during World War I. Many new and unusual features developed in connection with the War and Kew had to deal with

Members of the Kew staff who were seconded to other departments or were on active service in England and other countries during the war were—Messrs. J. S L. Gilmour, B.L. Burtt, A. A. Bullock, E. Milne-Redhead, A. K. Jackson and Miss E. A. Bruce. Other members also did considerable war work in connection with A. R. P. etc.

KEW AND INDIA

Kew has maintained a close and cordial relation with India since its beginning This was mainly done through the Botanic Garden at Sibpur, Calcutta, which was the centre of the Botanical Survey of India in the past It is some what by co-incidence that there exists a close resemblance between Kew and the Calcutta garden Both these gardens had their origin in private enterprise, both are situated on the banks of important rivers within the close vicinity of two very well known cities of the world and in the present time both these gardens serve as centres of important botanical research work. As a government garden, the Calcutta institute is much older than Kew though considering the real beginning and the volume of work done in Kew, the latter institute stands distinctly as a pioneer Besides the publication of a large number of floras already stated above the members of the Kew Garden staff have contributed in various other journals of the world little over two thousand separate research papers (See *Kew Bull* 1897 p 1—88 and 238—240 and *Kew Bull* 1907 appendix V, p. 95—152) This intensive work could only be achieved because "Kew, in truth, has no politics or any aim, but to accomplish useful work" The aim of Kew is to be international in the right sense of the word and not national.

The most valuable plants introduced to India through Kew are the South American *Cinchonas*, the source of quinine The flourishing plantations now existing in Sikkim Himalayas (Mungpoo and Munsong) and the Nilgiris, and responsible for the production of good quantity of quinine for the average people of India, owe their early origin entirely to Kew and Kew-trained personnel. In return, India has given Kew seeds of *Hydnocarpus*, the source of *Chaulmoogra* Oil the specific for the scourge of leprosy and thus enabled Kew to send out plants to other tropical countries where leprosy is prevalent. Other plants which were of recent introduction in India from Kew are the Chinese Tung Oil plants (*Aleurites Fordii and Aleurites montana*) The Para rubber plant (*Hevea braziliensis*) was first sent to India from Kew for experimental cultivation but the climate did not suit and the cultivation was later taken up in Ceylon and Malay Peninsula The common *Bougainvillea* of Indian gardens is a native of South America and was introduced in recent years in India through Kew.

The Government of India has for many years maintained an Assistant for India at Kew to deal with matters of systematic and economic importance. Recently young Indian botanists are being sent for a few years whose services would benefit the country on their return. This is undoubtedly a move in the right direction considering the immediate possibility of an expansion and reorganization of the Botanical Survey of India The Government of South Africa has been doing this for the last few years and has made a well organized department to deal with plant taxonomy in their country On their invitation Dr Hutchinson of the Kew Gardens staff recently spent more than a year in South Africa as an adviser. The assistant for India besides attending to routine work of the Herbarium at Kew may benefit his country in many ways The main work should be the authentication of Indian Herbarium sheets with so many thousands of type sheets of Indian plants which are lodged at Kew. These type sheets have been the subject of considerable interest in recent years and suggestions have been made that they should be returned to India and kept somewhere in India when the proposed *National Herbarium* for the country is established. It is not very easy to get these types back because the earliest collections of Indian plants did not reach Kew, as at that time it had no Herbarium Those collections went to places like the British Museum, Gray Herbarium, Germany, Edinburgh, etc The later collections which are at Kew and on which many types are based, were according to Kew "acquired by purchase or by deed of gift and there can be no question as to their present ownership, nor can there be any question that they are in their rightful place considering that they contain many type specimens on which the Indian floras prepared at *Kew* are based "

In view of above, and as a first step towards building a *National Herbarium in India* the collections of some important Herbaria in India should be sent to Kew for authentication with the type sheets. This will involve intensive work, and for this two or three well trained taxonomists from India should be sent to Kew Unless this is done at an early date the superstructure of the Botanical Survey can not be built The facilities of such a work will never be denied at Kew, and after this hard work a degree of independence would come to the botanical workers in India as they will, so far as the Indian plants are concerned, have a herbarium almost of equal quality to that of Kew with every sheet matched and authenticated with the types at Kew and elsewhere. Such sheets can be regarded as valid standards for taxonomic and nomenclatural purposes.

VAGARIES IN ETHNOLOGY

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EVERY science must be precise and unequivocal in the use of its terms and anthropology is not excepted. As such we in anthropology must be sure of the denotation of the terms we use and must be clear in our statements of what they connote. Unfortunately this is lacking in all works of standard authors, not to speak of the amateur anthropologists

Leaving out the consideration of the racial nomenclature for the whole world, let me confine myself to the consideration of the terms used for racial types found in India.

The pioneer in the field of study of the races of India is Risley He made an anthropometric survey of the people of India and classified them into seven ethnic types (*Turko-Iranian*, *Indo-Aryan*, *Aryo-Dravidian or Hindusthani type*, *Scytho-Dravidian*, *Dravidian*, *Mongolo-Dravidian*, and *the Mongoloids*). His basis of classification was the theories of origin I do not think it necessary to discuss here the validity or otherwise of his findings. But what concerns us here is the use of terms for the different racial elements involved He recognized three racial elements in India—*viz*, Dravidian, Mongolian and Aryan—the Turk and the Iranian as found in the composition of the Turko-Iranian type cannot be taken as primary ethnic elements.

The next systematic attempt at classification was made by G. Ruggeri. He made a searching enquiry into the existing anthropometric materials and synchronized them all into a systematic whole. He deciphered six racial elements which have entered into the composition of the people of India They are—

1. Negritos.
2. Pre-Dravidians (Australoid-Veddaic)
3. Dravidians (having affinity with H Indo-africians Aethiopicus).
4. Tall dolichocephalic (Mesopotamic ?) elements (Toda).
5. Dolichocephalic Aryans (H. Indo-europeus dolichomorphus).
6. Brachycephalic Leucoderms (H. Indo-europeus brachymorphus).

The next attempt was made by Dr Hutton in collaboration with his assistant Dr B. S. Guha. They are—

1. The Negrito.
2. The Proto-australoid,
3. The early Branch of the Mediterranean Race.
4. The second wave of the Mediterranean—a civilized section from the Persian Gulf.
5. The later waves of the Mediterranean—advanced in culture
6. The Southern Mongoloids
7. The Indo-Aryans

Almost simultaneously another attempt was made by Baron Von Eickstedt. He took measurements of about 3,000 living individuals and introduced the following threefold division of the Indian people with a number of sub-types

1. The Weddids.
2. The Melanids.
3. The Indids

It is now time to take account of our works. Have we got a clear cut idea regarding the ethnic elements in India after over fifty years of anthropological researches since Sir Herbert Risley published the result of his anthropometric survey of India in a paper entitled 'The Study of Ethnology in India' (1890) [1] The answer is in the negative We have the same old difficulty regarding the constituent element—not to speak of the loose use of terms for the various racial types.

The greatest confusion prevails as regards the conception of the term Dravidian Apart from the question of its being of linguistic origin and as such quite unsuitable, according to some, for a racial nomenclature there is the paramount confusion regarding the physical characters it connotes Sergi and Deniker pointed out long ago that Risley's Dravidians are comprised of two types —(1) medium stature and messorrhine ; and (2) short statured and chamaerrhine—although both are dolichocephalic. Following these savants, anthropologists are tempted to call the second group—Pre-Dravidian and the first —the Dravidian. Now the term Pre-Dravidian only indicates the chronological position—*i.e.* they came or were in existence before the Dravidians and as such it is very vague about the implication of the racial element or elements it connotes. Late Rai Bahadur R. P. Chanda would prefer to call this group *'Nishad'* from the Sanskrit word *'Nishad'* denoting a number of malicious tribes living in the hills and forests and described as "black" as crow, very low statured and short armed, having high cheekbones, low-topped nose,

[1] *Jour. Anthropo. Gt. Brit.*

red eyes and copper-coloured hair" Like Risley, Chanda based his theory on somatic measurements but revealed a greater consistency in drawing conclusions from them. Like Risley he is not obsessed by the longheadedness of both the groups, but tries to separate the two groups on the basis of nasal index. Further he gives preference to the priority of claim of the ancient Sanskritic writers—to the term '*Nishad*'.

Not being satisfied with this, G Ruggeri coined the term Australoid-Veddaic for the Pre-Dravidians He starts with the assumption that the Veddas of Ceylon and for the reason of that the primitive tribes of South India and the Australians are the same or of common origin But we are not yet certain about the affiliation of the Pre-Dravidians of India with any people outside her borders Furthermore Zuckerman has pointed out, "craniological evidence derived from the present populations of the Dekkan does not support the hypothesis of a Pre-Dravidian racial stock whose representatives are, amongst others, the Australians, the jungle tribes of Southern India, and the Veddas of Ceylon "

The same argument might be levelled against Dr Hutton's use of the term—Proto-australoid for the primitive people of India including the Veddas of Ceylon Further its connection with the Mt Carmel (Palestine) man and ultimately with the Neanderthal type of man in Western Europe is also questioned on more than one grounds. The Kish skulls have been pointed out as a connecting link between the Proto-australoid type of India with the Palestine man But the wide difference in nasal index between the Kish skulls (N. I. 52 7), Adichanallur (N. I 51. 62) and the Veddaic skulls at Mohenjo-Daro (N I. 51·6) cannot be so easily dismissed. Recent researches have, however, shown that they might profitably be traced to *Homo primigenius solensis*

Mr H. C. Chakladar observes[2], "The affinity of the South Indian primitive people with the Veddahs of Ceylon is unquestioned, and therefore I would propose that they be simply styled Veddaic, to save confusion, at least until we have a clear comprehension of their composition"

Further Dr Hutton revives the old theory of the anatomists following Huxley that the Australians are the modern representatives of the Neanderthals of old. At the instance of Lt. Col. Seymour Sewell who associates the Indian Proto-australoid type with the Australian aborigines on the one hand and with the Rhodesian skull on the other—Dr Hutton connects the Indian Protoaustraloids through the Palestine man with the western Neanderthals. At the first instance it might be pointed out that the statement of Lt Col. Seymour Sewell in course of a personal conversation with Dr Hutton of "the possibility of the derivation of the Proto-australoid type in India from a leptorrhine western type through a series of climatic modifications" can scarcely appeal to a man with a scientific trend of mind. According to Hrdlicka "The Neanderthaler evolved into later man".[3] Dr Hutton appealed to this But such a statement of Hrdlicka cannot refer to all modern types of man and to all parts of the world.

Further H. F Osborn has pointed out,

"It is true that some of the skulls in these existing races (Australian and Tasmanian) are extraordinarily platycephalic and show a retreating forehead, that others show supraorbital ridges almost as prominent as in the Neanderthals, that sometimes the prominence of the occipital union is very marked, that certain jaws show a very retreating chin Thus one or another of these Neanderthal features has been observed in these lower existing races, but all of these characteristics have never been combined in one race as constant features, and invariably associated as in all the skulls of the Neanderthals known to us."

"In brief, the Australian type of head has nothing in common with that of the Neanderthals except in a small number of characteristics in the region of the forehead and of the nose The distinguishing traits of the Neanderthal head and face are platicephaly, a retreating forehead, flattening of the occiput or lower portion of the skull, prominence of the supraorbital ridges, chin retreating or lacking, projection of the entire face owing to the peculiar form of the upper jaw, and the relatively small size of the frontal lobes of the brain " To speak in the words of Boule, "All these modern so-called Neanderthaloids are nothing but varieties of invidiuals of *Homo sapiens*, remarkable for the accidental exaggeration of certain anatomical traits which are normally developed in all specimens of *Homo neanderthalensis* The simplest explanation of these accidents, in most cases, is atavism or reversion We cannot assert that there has never been an infusion of Neanderthaloid blood in the groups belonging to species *Homo sapiens*, but what seems to be quite certain is that any such infusion can have been only accidental, for there is no recent type which can be considered even as a modified direct descendant of the Neanderthals".

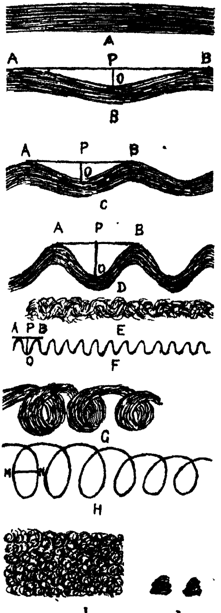
Osborn further observes, "This opinion (of Boule) is confirmed by the latest and most exhaustive researches of Berry and Robertson who conclude that neither Australians nor Tasmanians have any direct relationship with *Homo neanderthalensis*, the superficial points of cranial resemblance are explicable solely on the grounds of the remoteness of ancestry The Australians and Tasmanians are descendants not of the Neanderthal stock but of a late Pliocene or early Pleistocene stock, which following Sergi, may be called *Homo-sapiens tasmanianus*, of which the Tasmanian aboriginal, now extinct, was the almost unchanged offspring." (See Osborn—Men of the Old Stone Age, 1919, pp 232-234)

Again the question of the existence of the Negritos in the mainland of India has attracted the attention of the anthropologists and politicians alike. Husing and following him Ruggeri point out to the

[2] *Proc. 23rd Ind. Sc. Cong., Pres. Add. (Anthropo. Sec.)*

[3] *Jour. Roy. Anthro. Inst., LVII, p. 278.*

existence of a Negrito people along the coast of the Persian Gulf Ruggeri further believes that Dravidians in their migration from Iran to India might have brought some negrito element specially in their



A. Straight; B. Low Wave; C. Medium Wave; D. Deep Wave; E. & F. Frizzly; G. & H. Curly; I. & J. Wooly—a modification of Martin's (*Lehrbruch der Anthropologie*) and Sullivan's (*Essentials of Anthropometry*).

head form. Haddon also suspected a Negroid element in the Deccan. Dr Hutton, on the authority of Dr B. S. Guha thinks, "the earliest inhabitants of the Indian Peninsula were probably negroid in type and the Negrito, rapidly disappearing though he is, still survives in the Andaman Islands (Census, 1931, Vol. I, Part I, p. 442). Dr Guha points out that the Jewurgi skull described by Meadows Taylor in 1873 is Negroid. Further the Andamanese together with the Kadars and Pulayans are, according to him, Negrito apparently on the evidence of frizzly hair and short stature He is also, supposed to have found frizzly hair in the Angami Nagas of Assam. At the first instance it might be pointed out that the accidental discovery of one or two cases of the so-called frizzly hair (we have no account whether they have been examined under the microscope by any competent authority) can prove nothing

Now frizzly hair has been associated with woolly hair and both are regarded as a diagnostic mark of the Negroes or Negrito. Now let us see how far we are justified in doing so. Usually three types of hair are recognized—straight hair, wavy hair (to which is associated curly hair) and woolly hair (to which is associated frizzly hair). Wavy hair is again classed under three heads—low, medium and deep, according to the nature of the wave. As has been pointed out by L. R. Sullivan (Essentials of Anthropometry, 1928, pp 44-7), in the figure, if A and B represent the two adjacent apices of the waves and OP the depth of the wave, then a hair will be called of (*a*) a low wave if AB is about 5 cm and OP about 5 cm. and $\frac{OP}{AB}$ about 1/10 (Fig. B). It will be of (*b*) a medium wave if AB is about 3·5 cm and OP about 6 cm. and $\frac{OP}{AB}$ about ⅙ (Fig. C) and it will be of (c) a deep wave if AB is about 2·5 cm. and OP about 1·2 cm. and $\frac{OP}{AB}$ about ½ (Fig. D).

In frizzly hair, AB is about 5 cm. and OP ·5 cm or slightly less and $\frac{OP}{AB}$ is about 1 (Figs. E & F). It does form a curl or spiral.

A curly hair (Figs. G & H) again does not form a wave. It is chracterized by "the same long spiral curls" which varies from two to three centimeters in diameter *i.e.*, MN = 2 cms. to 3 cms.

A wooly hair (Figs. I & J) also forms spirals, but the diameter of the spirals is not the same all through. It is around 2 centimeters near the head and dwindles gradually as the spiral continues.

This being so, a frizzly hair has a greater claim to be associated with wavy hair and curly hair with

woolly hair It is therefore doubtful whether such a frizzly hair can be taken along with woolly hair as a criterion for distinguishing Negrito element. But unfortunately microcephalism, which is undoubtedly a distinguishing feature of the negritos has been left out of account No attempt has yet been made to study the head characters of the so-called Negritos and determine the percentage of microcephalism in them. Until this is done it will be too early to call them Negrito.

Again Keith attributes the brachycephalism of south Arabia not to a Negrito element but to a type which is non-armenoid in dimension and Dixon to an Alpine people. Further D. Buxton (The Peoples of Asia, p. 135) observes:

> "Some writers, basing their opinion very largely on the curly hair of some of the tribes of Central and Southern India, have maintained that there is certain evidence of Negrito blood. The dark colour of some of the tribes has also been put forward as a piece of evidence to support this thesis. Such a theory, however, seems unnecessary to explain the facts which can be accounted for on other grounds, it being quite certain that some of the races of Europe have curly hair No people of pure Negrito blood have been found, as far as I am aware, in India and until further archaeological work reveals evidence of such a people it would seem better not to admit their presence in the area."

Further Dr Hutton avoids the use of the Dravidian. Is it that the first of the immigrations of the Mediterraneans refer to the Dravidians? He brings the Mediterraneans in three successive waves and also brings the brachycephals along with the first and third of these waves, probably to explain the brachycephals in India.

One glaring defect of Eickstedt's classification is that he does not take into account the brachycephalic element in India. Again the distinction between the Melanids and the Weddids on the one hand and the Indids on the other is very vague. Further although he started with the mission to avoid all linguistic terms, he could not avoid the use of the term Kolid, a varient of 'Kolarian', a term linguistic in origin.

If this is our position regarding the ethnic composition of the people of India, it is useless to theorize —far less to speculate about the applicability or otherwise of particular terms. Terms are there, no matter whether they are of linguistic origin or not. They are so many names arbitarily given to particular groups of mankind and when they are given, they are, to speak in the terms of logic, without any connotation, but subsequently they acquire an infinite number of connotations Again they should be so selected as not to give the idea that a particular people is confined to one and one country only when it is apparent that a collateral branch of the same stock might be found in another country: as such Eickstedt's use of the term Indid is misleading. Again we must not rush to coin new terms That only makes the confusion still more confused Priority of claim, when possible, must be given and what should be done is that we should define every term, by definite International Rules of Anthropological nomenclature, as is done in other biological sciences But above all we must be up and doing in collecting data. Most of the earlier authors suffer from inadequacy of data on which they build up a racial classification. Their number in no case exceeds three thousands (*i e*, about 0 0008 per cent) when compared with the vastness of this sub-continent with a population of over thirty six crores divided into a number of endogamous groups.

VAVILOV AND THE SOVIETS

R. RUGGLES GATES*

PROFESSOR NIKOLAI IVANOVICH VAVILOV was the leading plant breeder of his time in Russia, and he was much more. His abbreviated but meteoric career ended—like that of a meteor-in-destruction. Little is available regarding the usual biographical details of his life. Born in 1885, nothing appears to be known (outside Russia) of his early life or even his birth-place. His father was a manufacturer of textiles ; his sister, a medical woman who died of typhus in the first world war.[1] He married and had two sons. His brother, Serge, is a physicist, professor in Moscow University and now president of the USSR Academy of Sciences. He was recently awarded the Stalin prize in physics of the USSR, following its award to Kapitza and Joffe.

Vavilov came to England in 1913 and worked at the John Innes Horticultural Institution. I met him at that time, and well remember his rather disconcerting question, then or later, "What is your philosophy?" To explain one's "philosophy" in a few words, or even in many, on the spur of the moment, is rather a large order. He was then, as always, a hearty man of abounding vigour and unlimited energy. His compact build, dark complexion, wavy black hair, and booming resonant voice made him an unforgettable figure in any scientific gathering. His boundless energy was devoted to the collection and study of varieties of cultivated plants from all parts of the world. By growing them in all the varied climates and soils of Russia, from Arctic to sub-tropical conditions, he added greatly to the agricultural resources of his native country and made contributions to the geography of cultivated plants which are more important than any since DeCandolle

The early interest of Vavilov was in the fungus diseases of cereals, as shown in his paper, "Immunity to fungus diseases as a physiological test in genetics and systematics, exemplified in cereals."[2] He was then at the Agricultural Higher School, Petrovskoie-Rasumovskoie, near Moscow, and his attention was already focussed on taxonomic characters in relation to susceptibility, having already published three papers on the subject. Among other results, he cites the finding of only one variety of wheat (*Triticum vulgare*) in 580 which was immune to mildew (*Erysiphe graminis*), the immunity being inherited as a single recessive character, in the same way that Biffen had found immunity to rust a recessive character in wheat. Vavilov showed a complete grasp of the complex host-parasite relationship, and he found the fungal parasite reactions as sensitive as the serum reactions then being studied in plants. Later, in 1918, he wrote a book on "*Immunity of plants in infectious diseases.*"

In 1917, Vavilov went to Saratov on the Volga, the leading wheat-breeding centre in Russia, as professor of agriculture, botany and genetics. Here he published a paper on the origin of cultivated rye In Afghanistan he afterwards obtained further evidence in support of his theory that rye originated as a weed in the more southern wheat fields, finally supplanting wheat through climatic selection in northern and mountainous regions. As the seeds of both plants were mixed in harvesting, the rye survived as the main crop in the more northerly latitudes, to which it was better adapted.

He afterwards developed a similar hypothesis that species of oats were at first impurities in crops of emmer (*Triticum dicoccum, one of the most primitive of wheats,* said to have been cultivated in Babylon as early as 4000 B.C.), in Persia, Caucasus and Volga regions. The culture of this primitive wheat was found surviving among the Tartars of Kazan and Simbirsk on the Volga, among the Chuvash ("bearers of antiquity"), and in the Caucasus by Ossetes, mountain Georgians and Armenians. In support of his views, a series of endemic oat varieties were discovered as very primitive admixtures with emmer.

In 1922, Vavilov and Kuzentzova published at Saratov a paper "On the genetic nature of winter

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* Dr R. Ruggles Gates, F R S., is Emeritus Professor of Botany in the University of London, and author of *'The Mutation factor in Evolution'* (1915), *'Mutations and Evolution'* (1921), *'Heredity and Eugenics'* (1923), *'A Botanist in the Amazon Valley'* (1927), *'Heredity in Man'* (1929) and his latest authoritative work on *'Human Genetics'* in 2 vols (1946). Dr Gates is a biologist in the widest sense, and there are few phases of this science to which he has not contributed in an active life of teaching, research and travel. He first acquired international recognition through his discovery of different chromosome numbers in the mutations of de Vries, and his lifework includes important contributions to cytology, plant breeding, anthropology and eugenics, and to the study of mutations, blood groups, and racial crossing. Dr Gates visited India as a delegate to the Silver Jubilee session of the Indian Science Congress Association in 1938 and a brilliant school of Indian Cytogeneticists had their training under him.

Dr Gates is now 65 years of age. He left England in 1940 to work at the Marine Biological Laboratories, Woods Hole, Mass. and since December, 1946, he has been appointed a Research Fellow in Biology of Harvard University and is now engaged in completing a book on *'Human Ancestry'*.

[1] These facts are taken from the obituary notice by Harland and Darlington (*Nature, 156,* 621, 1945).

[2] *J. Genetics, 4,* 49-65, 1914.

and spring races in plants". This subject was later to become a bone of contention, and this paper was probably used in the attack which led to his downfall.

Another contribution of first class importance made by Vavilov concerned the laws of variation in plants. In 1912 the present writer first used the term *parallel mutation* in describing the same mutation (*lata*, with broad leaves and 15 chromosomes) in two different species of *Oenothera*. Later,[3] many such cases of parallel mutations and variations were pointed out in a wide range of plants and animals. Vavilov, in applying the same conception to cereals and other plants, wrote of "The law of homologous series in variation".[4] In this paper, which has often been quoted, Vavilov showed how large numbers of homologous or parallel variations exist in cultivated cereals and many other plants. He pointed out that Mivart[5] had first used the phrase "law of homologous variation in 1871". Later, in 1925, Vavilov made a study of "Inter-generic hybrids of melons, watermelons, and squashes", to which he added a schema of homologous variations in the members of this family, concluding that similar characters found in different genera were not due to intercrossing but to what we would now call parallel mutations.

Vavilov's great opportunity came in 1921 when Lenin, no doubt impressed by his vigorous activity, chose him as Director of the Institute of Applied Botany and President of the Lenin Academy of Agricultural Sciences. He thus found himself, at the age of 36, in a position for developments in plant breeding unparalleled elsewhere. Throughout the vast Soviet area of Europe and Asia he established over 400 experiment stations and research institutes. The headquarters Institute of Applied Botany and New Cultures, in Leningrad, alone had twenty-one heads of divisions by 1929, and a scientific staff which reached 158. The Bureau of Applied Botany and Plant-Breeding was set up in a palace at Detskoje Selo, near Leningrad.

In 1926 I was invited to visit Russia and inspect particularly the plant breeding stations. Arriving at Leningrad from Helsingfors in Finland, I met the Director of a station which had been established three years previously at Khibiny, within the Arctic circle, in Russia Lapland. We travelled northwards a thousand miles, past Lakes Ladoga and Onega and the White Sea. At this station the tundra vegetation of mossess and lichens had been removed and potatoes and strawberries were among the crops being successfully grown, the aim being to develop vegetables and fruits for the Arctic. Vavilov's plan was to test the vast collections of seeds from many countries by growing them in the great variety of soils and climates to be found in the Soviet Union, thus obtaining comparative reports of their performance. Even maize and cotton were tested at Khibiny, the former reaching only a foot in height while the latter promptly died at an early age.

Longer visits were made to Detskoje Selo, Moscow and Saratov, as well as the Caucasus, Tiflis, and Batoum, entailing journeys of probably ten thousand miles in European Russia at a time when parts of the country were still in a disturbed state and overrun with bandits. At Detskoje Selo the extensive plant breeding experiments were under the more immediate supervision of Vavilov, with the aid particularly of Levitsky and Karpechenko as cytologists and Pissarev as agronomist. The great Saratov station, whose head was Michaelis, was devoted mainly to wheat breeding but also to sun-flowers (an important crop in southern Russia) and other plants. They showed me a series of interesting hybrids between wheat and rye, some of which bred true. I was able to recommend that these be examined by a cytologist, and by this means they were able to show later that these were what are now known as amphidiploids, *i.e.*, hybrids which had doubled their chromosomes and so produced a stable form.

The *Bulletin of Applied Botany and Plant Breeding*, which was founded by Robert Regel, had reached volume 14 in 1924. Vavilov remodelled it, adding *Genetics* to the title, and in the following seven years published a shelf-full of volumes. They make a memorable series of contributions, written mainly by himself and his collaborators, including a very great range of cultivated plants from all lands, dealing chiefly with the geographic distribution of different genera throughout the world, and generally having an extensive summary in English. This journal alone, of the period 1924-31, will be a monument to Vavilov for many years to come.

Another aspect of Vavilov's activities was his numerous expeditions in search of agricultural plants, when he frequently travelled by himself and suffered many hardships. The first of these journeys was to Persia in 1916, where he collected mainly cereals. He was in search of "Persian wheat", which had been received in 1911 from a German seed firm and was very resistant to mildew. Many samples of Persian wheats were collected through the British consuls, but this was not among them. Later it was found by others in Georgia and Armenia under the name *dika*. Vavilov described it as a new species, *Triticum persicum*, and found references to it in a 10th century manuscript. In 1924, in company with

[3] Gates, 1920. *Mutations and Evolution*. Cambridge Press.

[4] *J. Genetics*, *12*, 47-89, 1922. This had been published in German at Saratov in 1920.

[5] Mivart, St. G., 1871. *On the Genesis of Species*. London.

two others, he travelled some 6000 kilometres, much of it on foot, in Afghanistan, the result being some 7000 samples of cultivated plants, and a book of 610 pages on *Agricultural Afghanistan* by Vavilov and Bukinich in 1929. This volume gives maps of the vegetation with descriptions and illustrations of the primitive agricultural implements, the irrigation, crop plants, the cities and their people. Among the many peculiar vegetables are black and purple carrots. Other varieties were yellow or even nearly white, but none were orange in colour. The native word for carrot is *zardek* and *zard* means yellow.

In a study of the Afghan carrots collected by Vavilov, Matskevich agrees with him that the centre for the greatest variety of carrots and other crops is in the region of the Hindu-Kush to the Himalayas. The names for the carrot, from Central Asia to Cape Comorin, are all derived from Sanscrit—*garjaru*, as shown by Watt. The Persian, Arabic and Afghan names are probably from the same source. It is thus evident that they were extensively cultivated in India long before they reached Europe from Central Asia.

Other expeditions were made to Mexico, Guatemala, Colombia, Peru, Bolivia and Chile, extensive collections of wild species of potatoes as well as cultivated varieties being made in the latter countries. These show an enormous range of variation in type of tubers as well as other characters, in contrast to the single species hitherto in cultivation. This work began a new era for the potato as a cultivated plant. For instance, potatoes from the Andes in equatorial latitudes were found, whose growth is adapted to a short day, in contrast to the long-day potatoes characteristic of our northern climates. These expeditions were planned by Vavilov and in considerable part carried out by him.

From his vast collection of the cultivated plants of many countries, Vavilov made another important generalization. In 1927 he wrote[6] a paper on "Geographical regularities in the distribution of the genes of cultivated plants," in which he developed the thesis that the "principal centres of origin of cultivated plants are connected to a considerable extent with the distribution of the principal seats of the primary human culture" and to some degree with centres of diversity of domestic animals, thus relating plant varieties to agricultural developments in the Neolithic. He concluded that there were five principal geographic centres of origin of cultivated plants: (1) Southwestern Asia, and the mountainous regions of (2) China, (3) the Mediterranean coast, (4) East Africa (Abyssinia and Eritrea), (5) Mexico, Guatemala, Colombia and Peru. Secondary centres were recognized in islands such as Japan, Java and Sumatra. He regarded Abyssinia as the principal centre for emmer wheat, barley and the oat, *Avena abyssinica*. His views were further elaborated at the International Genetical Congress in Berlin in 1927.[7]

While there is much in his contention, it now appears that there are numerous exceptions and that the rule that the oldest centres of cultivation have the most varieties can only be applied in a general sense. For example, Vavilov found more varieties of emmer wheat in Abyssinia than elsewhere, but they are all glabrous, whereas Bhatia[8] found a pubescent (more primitive) variety in India and concluded, with Percival, that the home of emmer was in the region of Caucasia, Armenia, Syria and Palestine, the culture probably spreading from Babylonia.

Vavilov's election as an Academician of the U S S R. appears to date from 1929, but his triumph was short-lived. By the end of 1931 his name ceased to appear as Director of the Institute, although his papers continued to appear in the Bulletin for a time. In 1930 the name of the Leningrad Institute was changed to the State Institute for Experimental Agronomy. This is presumably when Lysenko took over. Karpechenko disappeared from the scene at the same time.

The Seventh International Genetical Congress was to have been held in Russia in 1937, but it was announced that the Congress was cancelled by the Soviet authorities and that Vavilov had been arrested. This was denied and the Soviets then stated that the Congress was not cancelled but "postponed". Vavilov wrote to *Izvestia* and the *New York Times*[9] on December 23, 1937, defending science in the Soviets and pointing out the great increase which had taken place in funds for the Institute. At the same time Prof. Agol, a cytogeneticist, who was Director of the Genetics Laboratory of the Ukraine Academy of Science at Kiev, and an active worker, was arrested as a "Trotskyite murderer".

When the Congress was finally arranged to be held in Edinburgh in 1939, Vavilov was invited to be President. He at first accepted, but the whole Russian delegation was cancelled at the last moment, and the programme had to be rearranged.

It is worthwhile pointing out here that December, 1937 was the time when Levit's Medico-Genetical Research Institute in Moscow was also attacked, at an All-Union Congress of Psychiatrists, and he was denounced as a "false scientist". His Institute had been publishing much valuable work for several

[6] *Bull. Appl. Bot., Genetics & Plant Breeding*, 17, No. 3, 411-428.

[7] *Zits. f. Abst. u. Vererb Suppl.*, 342-369, 1928.

[8] Cytology and genetics of some Indian wheats. *J. Genetics*, 35, 321-349, 1938.

[9] Details in *J. Heredity*, 28, 24-26, 1937.

years in human genetics, but it was liquidated and he has not been heard of since One of the accusations was that a member of his staff had tested the Intelligence Quotient of the Buriats in Siberia and found it lower than that of some other peoples. This was found to be contrary to Marxian doctrine and therefore untrue Those who had engaged in this research were obliged to recant and express their grief at having been so misled as to make such experiments.

Only brief reference can be made here to the way in which Vavilov's career was terminated He was quickly shorn of all his powers and activities, but in 1937 was made President of the Russian Geographical Society in Leningrad In 1942 he was elected a foreign member of the Royal Society, giving at that time a private address in Moscow. His death was announced in 1945, but without details of place or date. How long he had been in a concentration camp is unknown The nature of his end may be surmised from the universal reply when Russians abroad are asked how he died. They say, "We do not talk about these things"

Vavilov was a convinced Communist Perhaps the following incident throws a side-light on the atmosphere of Soviet Russia in 1926 I was attending an informal dinner at which Vavilov and two or three other plant geneticists were present with their families During the conversation, when someone referred incidentally to the King of England, a youngster five years of age intervened to ask why the King of England had not had his head cut off! He could not understand the evidence oversight!

The controversy between the Vavilov school of Mendelian geneticists and the Lysenko school went on from about 1932 to 1940. Lysenko was not the original discoverer of vernalization. The main principle is that if seeds of winter wheats and some other cereals are moistened so that they partially germinate, then subjected to low temperatures in darkness for 50 to 65 days, and sown in spring, they mature rapidly like spring wheats. McKinney and Sando show[10] that this method was reported and used by Klippart in Ohio in 1858 Winter wheats differ physiologically from spring wheats in having low-temperature and short-day optima in their early growth phase, while spring varieties have their optimum at higher temperatures and longer photoperiods. Garner and Allard did important work as early as 1920 on the varied responses of plants to length of day.

Lysenko published his account of vernalization in the Ukraine in 1932, and in that year 250,000 acres were sown with vernalized seed. His first account seems to have appeared in a Russian agronomic newspaper in 1929. The matter has since been studied extensively by plant physiologists and agronomists, and the method has been applied to many plants with varying success. Many interpretations of the phenomenon have been made. An Italian (Crescini) regarded the change as a mutation, but an ordinary mutation is ruled out by the fact that the change takes place long after fertilization. Moreover, Lysenko appears to be the only one who claims that the change is inherited. It has been shown that vernalized seeds have less auxin (growth hormone) and that vernalized wheat respires more rapidly.

It is obvious that such physiological responses to temperature change are in the same category as the responses to light in long-day and short-day plants The biennial or annual habit is well known to be similarly amenable to growing conditions. The evening primroses (*Oenothera*) are mostly biennial, but by early sowing in the greenhouse they can be grown as annuals, the rosette stage being shortened or in some cases almost entirely omitted But the seeds from annual plants produce biennials unless they are again grown in conditions which induce early shoot formation All plant species have undergone adjustment to the temperature and other conditions in which they naturally grow

It is not necessary here to adjudicate on Lysenko His ideas at their best are complementary to but not contradictory to the results of genetics The naiveté of his position is clear from his recent publication "Heredity and its Variability".[11] Even if his claim that vernalization is inherited has some basis in fact, it would not touch the core of the Mendelian position, but would merely show that there may be a category of physiological characters which behave differently from the great bulk of Mendelian characters, which are not so adjustable. But this is far from being proved, and many of his experiments, as in grafting of tomatoes, are purile in their method and lack of controls. Many of his supposed results could be equally well explained by different forms of selection in his crops. Statistical treatment is forbidden and even the law of genetic segregation is denied.

The outlook of Lysenko may be judged from his reference (p 45) to "the best biologists, Burbank, Vilmorin, and particularly Michurin". When a man seeks, on the basis of a few inconclusive and ill-controlled experiments, to overthrow a whole established field of science, he is generally recognized

[10] J. Heredity, 24, 169-179, 1933.

[11] Translated by T. Dobzhansky. Pp. 65. King's Crown Press, Morningside Heights, New York. First published in 1943 by the Commissariat of Agriculture of U. S. S. R.

as a charlatan One hesitates to apply that term to Lysenko, but he can be charged with extreme egotism and conflict with the traditions of science as the search for truth, in the use he has made of his few dubious results, instead of trying to build them, such as they are, into the edifice of science. Much of his pamphlet is just plain balderdash On p 52 we find the statement, "Cytogeneticists take the view that heredity is a special substance!" He thus not only puts himself out of court as a scientific man, but in his journal *Yarovizatsia* he has tried to suppress all teaching of Mendelism in Russia

Hudson and Richards[12] have recently summarized in a masterly way the psychology and views of Lysenko and his method of interpreting experiments They go to extremes to state his ideas in the way he would state them himself. Ashby[13], in a review, shows that in spite of the authors' elaborate care and extreme fairness of statement, Lysenko's ideas are left in a parlous state Khvostova recently repeated Lysenko's grafting experiments with tomatoes and shows that his results were merely due to heterozygosity Some others which he attributed to heredity were due to spotted wilt.

Such a fantastic and tragic episode in science as we witness in the cases of Vavilov and his would-be rival, Lysenko, could only happen in Russia under the Soviets It is significant that in 1932, at the beginning of the controversy, a resolution was passed in Leningrad that genetics and plant breeding were to conform with the tenets of dialectical materialism One might think that astronomy at least would be sufficiently other-worldly to escape purges and executions, but last year it was reported from Russia that seven astronomers had been shot Prof W Savicki, formerly professor of genetics at Kiev, and his wife, now interned[14] at Oberammergau, Germany, report that if returned to the Ukraine they would be executed "because they hold the views of Western World geneticists" The tyranny of Sovietism can only be viewed with horror by the scientific men in countries free from Soviet rule

[12] The New Genetics in the Soviet Union *Imp Bur Plant Breeding*, Cambridge, Pp 88

[13] *Nature*, *158*, 285-287, 1946

[14] *Science*, Aug, 2, p 108, 1946.

OBITUARY : PROFESSOR PHANINDRA NATH GHOSH

BY the death of Professor P N Ghosh, Sir Rash Behary Ghose Professor and Head of the Department of Applied Physics, on the 23rd December, 1946 at the age of 63 at his own Calcutta residence, the University of Calcutta lost a personality at a critical time when he was most needed for the consolidation and expansion of technological education in the province The Department of Applied Physics was deprived of a teacher who, by his fatherly love and affection and by his sincerity and genial behaviour, had fused the students and staff of the department into an undivisible unit and had led them to win many laurels in the fields of research, design and development under his able guidance. Bengal lost in him a leader who would have guided her in the post-war development of her new industries. His loss is indeed irreparable.

Professor Ghosh was born in February, 1884 in a respectable Kayastha family in the village of Mazilpur, 24-Parganas, Bengal. He lost his father at an early age and had to struggle hard for his education. After passing his Entrance Examination from the local H. E. School, he came to Bangabasi College, from where he graduated in 1905, standing first in Honours in Physics. He took his M.A. degree from the Presidency College in 1908, winning the University Gold Medal.

Professor Ghosh was offered many lucrative posts under the Government of Bengal but his ambition to become a technologist and his natural aptitude for research led him to reject them all although he was then in great financial difficulties. He joined the well-known firm of Jessop's as an apprentice and his mechanical skill and machine sense evoked admiration from his employers. Adverse circumstances forced him, however, to join the Bangabasi College as a professor of physics in 1910. He made his mark as a teacher His method of exposition was unique. His delivery was simply fascinating He was a giant for hard work and associated himself with many industries which were then growing in the province.

When the University College of Science and Technology was founded in 1914, Prof. Ghosh was one of the first choices of the late Sir Asutosh to fill the post of a lecturer in the department of physics He availed himself of this opportunity and very soon distinguished himself in the organization of the laboratory he was in charge of. His contemporaries envied the perfection he achieved in every detail of the laboratory. He made most of his time and devoted himself to research. He obtained his Doctorate degree in 1920 for his researches in optics, which were highly appreciated. In the same year, the late Sir Rashbehary Ghose made a princely gift to the

University for the development of technological instruction and research by establishing two University Chairs, one for Applied Chemistry and another for Applied Physics Prof Ghosh was the happy selection for the Chair in Applied Physics He was deputed abroad for ascertaining the curriculum of post-graduate studies for the training of youngmen of our country in the industrial application of Physics He visited the technological institutions of different foreign Universities The Honorary Degree of Sc D was conferred on him by the University of Padua He worked at the famous Siemens werke in Germany and returned to India in 1923.

PROF. P. N GHOSH

The post-graduate course in Applied Physics was formally opened in 1925 Professor Ghosh started the department, confining his activities to a single room and with a handful of back-dated measuring instruments and two one horse-power d c motors at his disposal for imparting instruction to the post-graduate students in electro-technology. By his untiring perseverance and relentless efforts, he built up the Department of Applied Physics to what it is today from those disappointingly meagre circumstances. Only those who had an opportunity to look into his laboratories, his lecture notes, his files and his personal library, could realise what amount of devotion and energy on his part was needed to build up this department from an idea to an achievement. The object with which he developed the various sections of the department was to impart to our youngmen a training which would enable them to play the important role of research worker and design-experts in the development of industries in the country.

Professor Ghosh organised research laboratories which were the first of their kind in India to undertake investigations on dielectrics molecular spectroscopy and design of measuring instruments. His spectroscopy laboratory is to-day one of the best equipped laboratories in the East He created a school of research workers around him and himself conducted a number of investigations in these lines, for which he won international fame and recognition. The Standardization Laboratory which he organised and developed in the department is so far the best in India.

Professor Ghosh was connected with many industrial concerns who were largely benefitted by his sound opinion and deep insight Under his Chairmanship the Industrial Survey Committee of the Government of Bengal submitted reports on the present positions of the vital industries in the province, indicating the lines of their future developments He was the Vice-President of the Bengal Industrial Research Board and sponsored many schemes for research and development He was chairman of the Scientific Instruments sub-committee of the National Planning Committee set up by the Indian National Congress

Professor Ghosh presided over the Physics Section of the 28th Session of the Indian Science Congress held at Benares in 1941 His presidential address was a masterly review of the role of Applied Physics in industry and was highly appreciated. He was a founder fellow of the National Institute of Sciences of India, a fellow of the Royal Asiatic Society of Bengal and a member of the Managing Committee and fellow of the Indian Association for the Cultivation of Science He was President of Indian Physical Society during 1943-45 and honorary secretary to the Board of Editors of Indian Journal of Physics for the last eleven years. Prof. Ghosh was Vice-President of the Indian Science News Association for several years and after the sad death of Sir U. N. Brahmachari acted in the interim vacancy.

Professor Ghosh has left indelible mark upon the annals of the University of Calcutta as Fellow of the Senate since 1932, as a member of the Faculties of Arts and Science and as a member of the different Boards of Studies and Committees.

Professor Ghosh loved his department more than his own life. It was only when he became physically very weak that he was persuaded to take rest from his heavy work at the department. Even lying in his sick bed, from which he did not rise again, he

used to discuss with his colleagues, research scholars and students about the working of the department and his plan for its future development For the cause of applied physics, he dedicated his life. He was indeed a martyr.

P. C M

Notes and News

CENTRAL ACADEMY OF SCIENCES

THE first meeting of the re-constituted 'Scientific Consultative Committee' which was originally formed in 1944 (See SCIENCE AND CULTURE, March, 1945, p 381), was held at New Delhi on February 9, last under the chairmanship of the Hon'ble Mr C Rajagopalachari, Member for Industries and Supplies

The committee unanimously decided that a paramount scientific body for India should be formed combining the National Institute of Sciences of India (Delhi), the Indian Academy of Sciences (Bangalore) and the National Academy of Sciences (Allahabad) The fellows of the existing academies should automatically become fellows of the new 'Central Academy of Sciences' and the existing academies should reconstitute as parts or branches of the new Academy

It may be recalled that the National Institute of Sciences of India was recognized as the premier scientific association in India by the then Government of India in November, 1945 (See SCIENCE AND CULTURE, November, 1945) The National Institute will now have to decide whether and to what extent it should modify its activities

The personnel of the 'Scientific Consultative Committee', (attached to the Department of Industries and Supplies) is as follows: 1 The Hon'ble Member in charge of the Department of Industries and Supplies, *Chairman;* 2 The Director, Board of Scientific and Industrial Research, *Vice-chairman;* 3. Dr Nazir Ahmed, 4 Prof. H. J. Bhabha, F.R S, 5. Sir Ramnath Chopra, 6. Sir Jnan Chunder Ghosh, 7. Sir Srinivasa Krishnan, F R.S, 8 Sir Venkata Raman, F.R S., 9. Prof M. N Saha, F R.S, 10 Prof B Sahni, F.R.S., 11. President, National Institute of Sciences of India, 12. An eminent Engineer nominated by the Institution of Engineers, 13. Director, Geological Survey of India, 14. The Master-General of Ordnance, 15. The Vice-chairman, Indian Council of Agricultural Research or the Agricultural Commissioner with the Government of India, 16. Director-General, Indian Medical Service, 17. Director-General of Observatories, 18. President, Indian Forest Research Institute, 19. The Chairman, Central Waterways Irrigation Navigation Commission, 20. The Animal Husbandry Commissioner with the Government of India.

A Deputy Secretary, Industries and Supply, *Secretary.*

The functions of the Committee will be as follows.—

To advise the Government of India on all general questions of policy relating to research throughout India and on any special matters relating to research which may be specifically referred to it

To co-ordinate scientific research which would include—

(*a*) Compilation and publication of information regarding research facilities available in India and of the work being done in India in both official and non-official organization,

(*b*) Suggesting ways and means by which the research work in various institutions can be better co-ordinated,

(*c*) Considering in particular, the progress of research work requiring collaboration of more than one department, and

(*d*) Constituting a focus for all official scientific activities and acting as a channel through which official communications may be made to other countries respecting scientific matters generally

PLANNING FOR INDIA

THE report of the Advisory Planning Board, set up soon after the new Interim Government took office (See SCIENCE AND CULTURE, November, 1946, p 228) recently published is a welcome correction to the numerous conflicting plans.

The Advisory Planning Board after reviewing official and non-official drafts, has now produced a plan for improving the planning machinery by the appointment of a whole-time Planning Commission of three to five members responsible only to the cabinet and assisted by a consultative body of 25 to 30 members.

The organization proposed would include a secretariat, consisting of a Central Statistical Office The duties of the planning commission would be to make recommendations regarding State aid and State control, foreign and internal trade, financial policy including currency and credit, allocation of resources and priorities and to watch and stimulate progress and execution of the plans and suggest future modifications.

The commission would have to be in close touch with the activities of the Scientific Consultative Committee and the board suggests that one of the first functions of this body should be to conduct a brief review of all research going on and advise regarding the research that should be taken up and encouraged.

The organization at the centre might also be found suitable for the provinces and refers specifically to agricultural planning, industrial training and State ownership of industries and an all-India mineral policy.

As regards priorities, stress is laid on the improvement of the supply of coal, cement and steel and also on the improvement of railway facilities, particularly for the transport of coal Priority has also been laid on the defence industries, food and other primary needs of the people

In a foreward to the report Pandit Nehru has made an appeal for 'constructive criticism' from the public

Application of science to human welfare was the main theme of an interesting symposium on National Planning held on Sunday, the 5th January, at Delhi under the auspices of the Indian Science Congress in which leading Indian and foreign delegates took part Pandit Jawaharlal Nehru presided

Initiating the discussion, Prof M N Saha, gave an account of planning in Russia He described the various stages of planning beginning with war communism between 1917 and 1921 and the creation of the Gosplan or State Planning Commission

Dr J N Mukherji dealt with soil problems in national planning and stressed the necessity of a land utilization and hydrological survey of India He pointed out that much of the sub-soil water is wasted.

Mr D N Wadia referred to the place of minerals in national planning He laid stress on the control of export of raw mineral ores.

Sir J C. Ghosh spoke on industrial planning and condemned the attitude of Indian capitalists (See *Science & Culture*, February 1947, p 345)

Prof. Bhabha specially referred to the leakage of scientific talent and proposed the setting up of a 'Scientific Manpower Committee'. He said while in Britain, 50 per cent of her potential man-power was being utilized in India not even one per cent is so utilized

Dr Rajendra Prasad gave an account of cereal shortage in India and how it was being met. He pleaded for a closer co-operation with the scientist and the farmer and he did not believe that the Indian farmer was conservative in their ideas

Dr Afzal Hussain pointed out that India should grow more tubers instead of cereals, which gave five times more calories than cereals

Dr Arthur Fleming laid special stress on knowledge which was a very important raw material for industrialists, by which he meant the training of technicians and workers. He stressed on the practical training to be an essential part of technical knowledge

Dr Dudley Stamp, stressed the right use of land as the most essential for any planning. A land utilization survey and use of under-utilized land was most important. He outlined the role of geographers in this respect and the importance of modern geography.

Dr Deming, pleaded for the support of fundamental research which was of basic importance He wanted statistics to be kept up-to-date

Winding up the discussion, Pandit Nehru spoke of the ever-increasing scope of science He thought that India was not *over-populated* He favoured the policy of self-sufficiency instead of economic imperialism He wanted the scientists to try to visualize their goal however dim and to have a picture of the society they wanted to develop. Ninety per cent of India's population live in villages and hence planning in India would mean planning of villages, *i e*, rural welfare

CENTRAL DRUGS LABORATORY

THE recent announcement by the Government of India of their decision to convert the Biochemical Standardization Laboratory into the Central Drugs Laboratory under the Drugs Act, 1940, will be welcome by all those who are interested in drug reform movements and in India's development of drug industry A vigorous effort has been made during the last 20 years by many members of the medical and pharmaceutical profession and trade to remove the present deplorable status of substandard and spurious drugs being sold freely in the Indian market to the detriment of the health and welfare of the public In 1930, the Government of India appointed the Drugs Enquiry Committee (Chopra Committee) which stressed the need for an immediate drug control legislation and the setting up of a machinery for the control and standardization of drugs. The report of the Committee, like many other reports, was left in the cold storage until about 1940, when an All-India Drugs Act was passed Though the nucleus of a laboratory under this Act (Biochemical Standardization Laboratory) was started, the legislation could not be implemented on account of the outbreak of the war. After nearly 16 years since the publication of the report of the Drugs Enquiry Committee, it has now been possible for the Government to start the Central Drugs Laboratory and to have the Drugs Act officially operated from 1st April 1947 It is to be hoped that this will usher in a new era of pure drugs and medical supplies for the teeming millions of this country.

DR B. MUKERJI : THE FIRST DIRECTOR OF THE CENTRAL DRUGS LABORATORY

WE are glad to know that Dr B. Mukerji, Officiating Director of the Biochemical Standardization Laboratory since 1941, has been appointed as the Director of the Central Drugs Laboratory. Dr Mukerji is associated with the drug control movement in India since 1930, when he served as the Assistant

Secretary to the Drugs Enquiry Committee. Along with Sir Ram Nath Chopra, he has been responsible for the proper functioning, for the first time, in this country of a drug standardization and control laboratory with chemical, pharmaceutical, pharmacological, biochemical and bacteriological assays under one roof

After a brilliant academic career in the Calcutta University, he joined the School of Tropical Medicine as an Assistant Research Worker to Sir R N. Chopra on Indian Indigenous Drugs in 1938. In collaboration with Chopra, he did much useful work in the field of Indian Indigenous Drugs and published several papers on the pharmacology and therapeutics of Indian Santonin, *Ephedra*, Squill, Yellow Oleander, *Ipecacuanha*, etc. In 1933, he was awarded the Rockefeller Foundation Scholarship, and he studied modern methods of advanced pharmacological and biochemical research in America, Great Britain and Germany

Dr Mukerji is largely responsible for the present all-India recognition of the Biochemical Standardization Laboratory in the field of drugs During the war years, this Laboratory did a considerable amount of testing work on behalf of the Defence Services and, by encouraging the use of Indian substitutes in place of imported drugs, has also helped a great deal in tiding over the very difficult situation arising out of the shortage of drug supply during the year 1943-44. Some of the results of researches of the Laboratories have now been incorporated in the Indian Pharmacopoeial List, the first publication of its kind in India, where standards for indigenous drugs of worth-while merit are recorded.

Dr Mukerji is an editorial collaborator of "SCIENCE AND CULTURE" and he has contributed a number of useful articles from time to time He is a Member and Fellow of many learned Societies in India, America, pre-war Germany, Switzerland, and Great Britain. He was elected the President of the Physiology Section of the Indian Science Congress at its Nagpur session in 1945 and a Fellow of the National Institute of Sciences in 1944. He is a Member of the American Society for Pharmacology and Experimental Therapeutics and also of the Swiss Medical and Biological Society. He has served as the Secretary of a number of provincial and Central Government Committees dealing with drugs and pharmacy. He served as the Chairman of the first and second Symposia of the All-India Pharmaceutical Conferences held at Bombay, Delhi and Bangalore We hope that, under his able direction and guidance, the Central Drugs Laboratory will continue to carry on its highly technical service with efficiency in the standardization and control of drugs and would gain the confidence of the public

ASSOCIATION OF SCIENTIFIC WORKERS OF THE ORDNANCE DEPARTMENT

AN Association of Scientific Workers of the Indian Ordnance Department including all the Ordnance Factories and Inspectorates of India under Ordnance Department has been formed The aims and objects of the Association, to state briefly, are to—

(1) Organize the whole body of scientific workers of Indian Ordnance Department,

(2) establish closer relationship among the members of the Association,

(3) find out ways and means to improve their status, and

(4) encourage research works among the members.

The first general conference of the Association was held on the 29th and 30th December, 1946, at Ishapore Representatives from different factories and Inspectorates of India came down and joined this conference It was resolved in the meeting that a committee should be formed to approach the Interim Government of India for their formal sanction and recognition of the Association The Committee has earnestly begun its work and submitted a memorandum to the Hon'ble Member of Industries and Supplies, Interim Government of India, for their kind recognition Mr H N Roy, M Sc, A.R.I.C (Lond), is the Honorary Secretary of the Association

SIR SHRI RAM INSTITUTE FOR INDUSTRIAL RESEARCH

DR JOHN MATTHAI, Member, Industries and Supplies, Interim Government (now in charge of Transport), laid the foundation stone of the Sir Shri Ram Institute for Industrial Research at Delhi on the 6th January last during the Science Congress week

The Institute will primarily function as an institute of applied scientific research in respect of industrial problems, carry out experiments and run pilot plants to test the results of these experiments The institute is estimated to cost Rs 20 lakhs and Sir Shri Ram is the donor

Declaring that private institutes of this kind would help industry to become research-minded and would be helpful to the various national laboratories which the Government propose to run, Dr Matthai said that at a period when private enterprise was on trial the world over the only way it could try to redeem itself was through raising the standard of efficiency and catering to the interests of the public. He further said that Indian industries would soon

be up against foreign competition, and unless prepared to meet the downward trend in prices—which was likely to appear sooner than had been expected—they might be in a difficult position

The need for industrial research and a closer co-operation between research and industry was stressed by Pandit Nehru.

INSTITUTE OF JUTE TECHNOLOGY

THE foundation stone of the 'Institute of Jute Technology' reported earlier (See SCIENCE AND CULTURE, July, 1946, p 31) was laid on the 20th February last, by Mr I. G Kennedy, President, Indian Jute Mills Association, at 35, Ballygunj Circular Road (Sir Taraknath Palit estates) close to the Biological departments of the Calcutta University

Mr Kennedy expressed the hope that the union of academic and commercial worlds achieved in the project would spread to other fields The jute industry formed an important part of the economic life of India, but it had lacked such an institution to train personnel in the efficient working of mills This gap is now being filled, industry and learning had combined to achieve a common purpose

Calling upon Mr Kennedy to lay the foundation of the Institute, Mr P N. Banerjee, Vice-Chancellor, Calcutta University said "It is for the first time in the chequered story of our University that science is being attempted to be harnessed to the needs of an industry which is of such paramount importance not to this province, nor to India alone but to the whole world." The young men trained at the institute would bring about a harmonizing peace and goodwill between the East and the West, between labour and capital

ROYAL ASIATIC SOCIETY OF BENGAL

THE 163rd Annual meeting of the society was held in the society's hall on February 3 last H. E. Sir Frederick Burrows, Governor of Bengal presided

The Hon'ble Justice Sir Norman Edgeley, in his presidential address gave a brief outline of a tour undertaken by him as a member of an expedition to Afghanistan. The scope of archaeological research in that country, he said was so immense, and there were so many promising sites for excavation, that it seemed that the time was at hand when the co-operation of India might be welcomed. India should be ready at all times in a spirit of neighbourly friendship to assist the Afghan Government by affording facilities for training in archaeological excavation and conservation work, by the exchange of missions and scholars and possibly by organizing loan exhibitions of antiquities.

Referring to the need for new premises for the society Sir Norman said that a rebuilding scheme, estimated to cost Rs 25,00,000 had been prepared and the Central and the provincial government approached for financial assistance. He announced that Mr Gajanand Khaitan had promised Rs 1,00,000 towards the cost of the building, construction of which would begin in about two years' time.

The following awards of the society's medals and prizes for 1947 were announced

Sir William Jones Memorial Medal to Prof Meghnad Saha, F R S, for conspicuously important Asiatic researches with reference to science including medicine

Annandale Memorial Medal awarded to Lt.-Col R. B Seymour Sewell, for his contributions to the study of Anthropology in Asia.

Pramatha Nath Bose Memorial Medal awarded to Mr D N Wadia for his contributions to practical and theoretical geology with special reference to India

Dr Bimala Churn Law Gold Medal awarded to Sir John Marshall for his contributions in History with special reference to India

Sarat Chandra Roy Memorial Medal awarded to Mr W V Grigson, I C.S for his monograph on the cultural anthropology of India.

Durga Prasad Khaitan Gold Medal awarded to Mr G D. Birla for his contributions towards the development of industry in India.

The undermentioned scholars were awarded the Society's Fellowship during the year 1946 ·

Sir William Jones Fellowship in Sanskritic studies to Dr Batakrishna Ghosh

James Prinsep Fellowship in Epigraphy and Numismatics to Mr R C Kar, M A

Rajendralal Mitra Fellowship in Buddhistic studies to Mr P. C Mazumdar, M A

R G. Casey Fellowship in Islamic studies to Miss Jahan Ara Khatun, M A

The following were duly elected as members of the Council for 1947: *President*: Dr B. C. Law, *Vice-Presidents*. Mr Percy Brown, Prof. S. K. Chatterji, Rai Bahadur Dr S. L. Hora and Dr R. C Majumdar, *Treasurer*: Mr. K P. Khaitan and *General Secretary*: Rai Bahadur Dr K. N. Bagchi.

WATUMULL FOUNDATION FOR 1947-48

THE Rev. Dr J H. Holmes, Ingersoll lecturer at Harvard University, has been appointed Rabindranath Tagore Memorial lecturer to Indian Universities for the year 1947-48. The lectures will be arranged

in co-operation with Benares Hindu University and the Inter-University Board, India.

Four Fellowships will be awarded for higher studies in United States in Political Science, Economics, Education, and Biochemistry or Applied sociology. The fellowship will carry a monthly stipend of $150 00 for two years.

The foundation will further give special Grants-in-aid to deserving Indian students already in U S A, needing assistance

A new programme of awarding Research Fellowships for advanced studies in Indian Universities is also inaugurated Ten such Fellows will be selected on All-India competition and stipend for each will be Rs. 1,600 a year for two years Graduates with M A, M Sc, or M.B honors from Indian Universities in agriculture, chemistry, economics, education, mathematics, medicine, physics, and political science should mail application by March 31st 1947 to J Watumull, Esq, Opposite Holmstead Hall, Fort Road, Hyderabad, Sind, India.

Two Fellowships (of the value of Rs 1,000 a year) will be available at each of the following institutions; Benares Hindu University, Jamia Millia Islamia, College of Engineering and Technology, Bengal, and National College, Hyderabad, Sind Applications should be sent through the Head of the Institution by 31st March, 1947.

ANNOUNCEMENTS

DR FRANS VERDOORN, Editor, *Chronica Botanica*, has been awarded the first Mary Soper Pope Medal of the Cranbrook Institute of Science, Michigan, in recognition of his editorial and international relations work in biology as well as for his researches in cryptogamic botany and the history of plant sciences

Born in Amsterdam (Netherlands), in 1906, Dr Verdoorn came to the U S.A. in 1940 He is the managing editor, of the Chronica Botanica Co., which publishes *Chronica Botanica, A New Series of Plant Science Books* and *Annales Cryptogamici et phytopathologici*. Dr Verdoorn is the author of 'de Frullaniaceis X-XVIII', 'Manual of Bryology', 'Manual of Pteridology', 'Plants and Plant Science in Latin America', 'Science and Scientists in the Netherlands Indies', and the 'Index Botanicorum'.

Mr Satyendra P. Basu, M.Sc., Superintendent of Fisheries, Government of Bengal has been awarded the Imperial Chemical Industries (India) Research Fellowship of the value of Rs 400/- P.M in Biology, by the National Institute of Sciences of India for 1947-48 Mr Basu will undertake investigations into the "Ecology of sewage irrigated fisheries in the Bidyadhari spill area, with particular reference to the Bionomics of carps cultured therein"

The Sixth Annual General Meeting of the Indian Ecological Society was held at Delhi on the 4th January last during the Science Congress Sessions and the following were elected as office-bearers of the society for 1947 *President* Rai Bahadur Dr S L Hora, *Honorary General Secretary* and *Editor, (Indian Ecologist)* Dr F R Bharucha

Brevet-Col Sir Ramnath Chopra, Kt, C I E, M D, Sc D, F R A.S B, F R C P, F N I, I M S (Retd), has been elected General President of the Indian Science Congress for 1947-48 and the following have been elected as sectional presidents

Mathematics—Dr R Vaidyanathaswamy (Madras) *Statistics*—Mr S N Roy, F N I (Calcutta) *Physics*—Dr L A. Ramdas, F N I (Poona) *Chemistry*—Prof B Sanjiva Rao, F.N I (Bangalore) *Geology & Geography*—Dr P. K Ghosh, F.N I (Calcutta) *Botany*—Dr K Ahmed Chowdhury, F N I (Dehra Dun) *Zoology & Entomology*—Prof A B Misra (Benares) *Anthropology & Archaeology*—Dr A. N Chatterjee (Calcutta) *Medical & Veterinary Sciences*—Dr G D Bhalerao (Bareilly) *Agricultural Sciences*—Rai Bahadur K D Sawhney (Hyderabad-Dn). *Physiology*—Dr Bashir Ahmad, F N I (New Delhi). *Psychology*—Dr C H Rice (Lahore) *Engineering & Metallurgy*—Mr N Sen (Jamshedpur)

Mr Ajit Kumar Saha, Junior Research Fellow of the National Institute of Sciences of India, has been awarded the Degree of Doctor of Science of the Calcutta University for researches in Nuclear Physics and β-ray Spectroscopy His examiners Madame Joliot-Curie, Prof Max Born, F.R S., and Sir C D Ellis, F R S. have spoken highly of his work.

Mr Sisir Kumar Guha, M Sc. Professor of Chemistry, Science College, Patna, has been awarded the D.Sc. degree by the University of Dacca on the unanimous recommendation of Professor W. H. Mills, Sc D, F.R.S, (Cambridge University), Professor F. M Rowe, D Sc. (Lond.), Leeds University and Professor S. B. Dutt, M.A. (Cal), D.Sc. (Lond), Delhi University Professor Guha submitted a thesis entitled "Studies on some thioindigoid, azine and azonium dyes—A correlation of colour with constitution."

SCIENCE IN INDUSTRY

ARTIFICIAL SUNLIGHT

THE illumination engineers of the General Electric Company have recently combined fluorescent lamps, mercury lamps, sun lamps, incandescent lamps and a water screening to produce artificial sun rays which almost duplicate the natural rays. This effective combination of lamps and water screen is the result of investigation into the composition and intensity of each spectral band of solar energy and also of the radiations emitted by the various lamps available.

In one test experiment, a dark room of the size of an ordinary office was selected. Light from six 3000-watt mercury lamps and 234 incandescent reflector lamps each of 300-watt was admitted into the room through a wire glass ceiling. Continuous sheet of water was circulated over this wire glass ceiling in order to absorb from the radiations of the lamps those spectral bands of the solar energy which are ordinarily absorbed by water vapour of the atmosphere. By this process the selective absorption suffered by the solar radiation was imitated. A row of 275-watt sun lamps and several rows of 100-watt fluorescent lamps, arranged in another section of the ceiling, were responsible for the ultra-violet rays. A fan was continuously run to eliminate part of heat of the fluorescent lamps through perforations in the ceiling. This partial heat elimination and the continuous dissipation of heat by the flowing water made available an abundance of infra-red rays into the room such as accompany solar radiations. The artificial sun light thus produced very closely resembled the natural rays in characteristics and intensity.

It was just an experiment and as yet far from suggests any commercial possibility in the immediate future for the simple reason that the power consumptions involved in lighting a single room by artificial sunlight was enough to light 100 houses.

NEW TEXTILE CHEMICALS

THE *Scientific American* reports a number of textile chemicals which will add chemical sinews to both natural and synthetic fibres and produce considerably improved varieties of rayon, cotton and woolen fabrics in future.

Resloom, a soluble melamine resin, is one such textile chemical. Resloom treated rayon, cotton and woolen fabrics have marked washable, non-shrinkable, mass-resistant, and long-life qualities. The process consists in immersing the cloth or fabric to be treated in a 20 per cent solution of the resin, then removing the excess moisture, and finally subjecting it to a temperature of 350° Fahrenheit. The resin deposits into a hard but pliable plastics to which the fibres adhere fast and produces a toughness which makes the fibres non-shrinkable. The resin treated fabrics, it is reported, are also better able to retain the crease.

Besides Resloom, a colloidal silica known as Syton, has been made available, which anchors the threads of nylons and rayons to prevent runs and slippage. Other chemicals include a new impregnated thread of great tensile strength for sewing linings, an organic amide insuring full protection against moths, a water-repellent resin, a midlow resistant agent; a soluble resin as a sizing agent, and a flame-proof chemical. Treated with one or other of these chemicals, natural as well as synthetic fabrics can have now qualities never thought of before.

SUPERSONIC WIND TUNNEL

According to a report of the *Bulletin of the Meteorological Society*, a 1500 m p h. wind tunnel has been designed to conduct tests on models of guided missiles and jet- and rocket-propelled aircraft. The tunnel is reported to be the largest in the U S.A. and is already in use at the Ames Laboratory of the National Advisory Committee for Aeronautics.

The system of jet propulsion perfected during the war has now made possible a tremendous speed even exceeding that of the velocity of sound. The tunnel will be used to conduct fundamental research on the design requirements for stable and controllable flight at such tremendous speeds. The tunnel is provided with a three-square foot test section through which air can be forced at velocities twice as high as that of sound. Electric motors totalling 10,000 h.p. will drive four three-stage centrifugal compressors to rotate at a constant speed of 5350 r.p.m. The pressure inside the tunnel can be changed over wide ranges, *e g.*, from a near vacuum to about three atmospheres, and variation of the scale of flight studied. Further, the pressure is maintained automatically by sensitive regulators. Several air-driers accurately control the humidity inside the tunnel and can produce as low a moisture content as only one per cent of the normal atmosphere.

We understand that the same Laboratory has now under construction another supersonic tunnel which is expected to be completed shortly. The tunnel will

exceed the former in its available range of testing supersonic speeds, and such high speeds as 2,000 m.p.h. can be conveniently studied for short periods of time. It will have a test section identical with the electrically driven tunnel to permit interchange of models, but it will operate intermittently from a huge pressure tank. All observations will have to be made within about 10 minutes, in which time the entire supply of high-pressure dry air will be exhausted.

IMPORTANCE OF BONE FERTILIZERS

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NEW YORK STATE COLLEGE OF AGRICULTURE,
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IMPORTANCE of the bone fertilizer industry cannot be under-estimated in a country like India where the natural phosphate deposits have been reported[1] to exist in a form in which they can be utilized economically for the superphosphate manufacture

In words of Pierre,[2] a famous soil scientist of U S A, "Phosphorus has sometimes been called the master key to Agriculture Its importance in general farming is indicated by the fact that low crop production is due more often to a lack of phosphorus than to the lack of any other element"

A rough idea as to the potentialities of bones as a source of phosphatic fertilizers may help in understanding the importance of this raw material in increasing the food supply of India The figures given here cannot be expected to be very accurate as there are so many uncertain factors involved

The total cattle (bovines[3]) population in British India, as well as in the Indian States are little over two hundred million heads[4] The ovines and others[3], though they number over 60 million heads in British India alone for the year 1936-37 and can be suitably used for manufacture of phosphatic fertilizers, will not, however, be taken into account. The purpose is to keep the whole set of figures on the conservative side. The average life of a cattle in India has not been estimated by the census figures According to the conservative estimates, the average life of cattle in India is six years The corresponding figures in the United States are 8-9 years in case cattle are not sent to slaughter. Thus assuming no man hastened death of cattle in India, there will be about 16 per cent annual turnover. The total annual turnover on this basis will be 32,000,000 cattle

The weight of an average cattle in India has been estimated as pretty close to 600 lbs. The Indian cattle being less fleshy and more bony, 16 6 per cent bones to the total carcass weight will not be far from correct figure. Thus 100 lbs. bones per cattle would make the annual turnover of bones equal to approximately 1,600,000 tons of bones

The importance and economics of bone fertilizers is in many ways linked with utilization of the carcass of the animals from which the bones are taken. Hides of the cattle form raw material for leather industry. Rest of the carcass can, however, be profitably used for preparation of meat meal.

Meat meal carries 9 to 11 per cent of nitrogen[5] and 0 1 to 3 5 per cent of phosphoric acid. The amount of phosphoric acid present depends upon the amount of bones that have been allowed to remain with the meat. The availability of nitrogen in meat meal is a little lower than that of dried blood which

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* The authors are indebted to Dr Richard Bradfield, Prof. of Soil Fertility and Head of the Agronomy Department, and Dr Herrel Degraff, Professor of Agricultural Economics, Cornell University, for their valuable advice and suggestions

[1] Royal Commission on Agriculture in India, 1928, p 93 "Reference should be made here to the extensive deposits of natural phosphates which are to be found in Trichinopoly district of Madras and in South Bihar. In neither tract do these phosphates exist in a form in which they can be utilized economically for the superphosphate manufacture and their employment in Agriculture has been limited to applications of the crude material in pulverized form This source of supply does not offer any important possibilities"

[2] "Phosphorus Deficiency and Soil Fertility", Pierre, U.S.D.A. Year Book, "Soils and Man", 1938, p. 377-392

[3] Bovines include cows, bulls, buffaloes, calves, etc
Ovines include sheep and goats.
Others include horse, camel, etc.

[4] (i) Agricultural Statistics of India, 1936-37, part I, P. XVII; British India Bovines 158 millions, part II, p. 2. Most of Indian States—Bovines 52 millions. Total 210 million bovines.
(ii) U.S.D.A Agricultural Statistics 1943-44; Total Cattle in India 205 million.
(iii) Memorandum of the Development of Agriculture & Animal Husbandry in India, of the Advisory board of the Imperial Council of Agricultural Research, 1943-44; p. 42; "Two hundred million heads of cattle. . . ."

[5] Collings, *Commercial Fertilizers*, 1941, p. 109.

has average nitrogen availability as 80. It means that one unit of nitrogen in dried blood is accepted as being 80 per cent as efficient in its crop-producing power under average conditions as one unit of nitrogen in sodium nitrate

The figures regarding the utilization of meat meal for better crop growth have not been included in this treatise which tends to clarify the role of bone fertilizers in a permanent system of agriculture that India needs so badly.

In making superphosphate, sulphuric acid to be added to the bones should be about half the weight of bones[6], accounting for weight of glasses lost and also for drying, the factor for conversion of bones to superphosphate will not be over 1·33 Thus calculating on this basis the total annual output may be 2,125,000 tons of bone superphosphate (P_2O_5 = 15 per cent).

Correlation of the amount of superphosphate added with the increase in yields obtained in case of various crops is the most uncertain factor in the whole calculations. It is known[7] that in many districts and, probably generally all over the country, the soil is poor in phosphates. Thus in Bihar soils, Davis[8] found that the total phosphorus percentage varied between 0·086 and 0·137 and available from a trace to 0 002 compared with about 0·27 and 0·016 respectively in good soils. The report of the Department of Agriculture of Madras for 1918-19 states that crying need for almost all crops[9] in Southern India is phosphoric acid. Mr Worth, Chemist, Dairy Institute at Bangalore, believed that deficiency of phosphorus was perhaps the most important Indian problem.

It has also been reported[9] that soils of Madras, Mysore, South East Bombay, Hyderabad, Central Provinces, Orissa, Chota Nagpur and South of Bengal are, as a rule, deficient in nitrogen, phosphoric acid and humus; but potash and lime are generally sufficient. In some of the *rugur* soils of India too, phosphoric acid, nitrogen and organic matter have been found to be generally deficient. Furthermore, the alluvial tracts of India, which are agriculturally the most important, have been found to be deficient in phosphoric acid, nitrogen and organic matter. The lack of phosphorus[7] in the soils in India is to a large extent the result of depletion. There has been a long continued export of phosphorus in the form of bones without any compensatory return. In spite of the fact that a significant portion of the total land area is deficient in phosphorus, it is very difficult to predict the crop response or to correlate the increase of yield with the amount of superphosphate added. It is possible that soils in certain parts of the country will not respond at all to phosphate fertilizers even though they are deficient in phosphorus, mainly because of water being a limiting factor. Similarly on other soils, nitrogen and organic matter may be bigger limiting factors and phosphatic fertilizers may respond poorly

Some previous experiments in this field can, however, serve as a guide The experiments which are being cited were reported by B Viswanath.[10] He writes, "A number of experiments have been carried out in different parts of India. 300 experiments reported in journals, bulletins and annual reports, and which appeared to have been carefully conducted, have been selected Of these, 43 experiments were conducted in dry or precarious areas and yielded results of an erratic nature. They are, therefore, eliminated. The remaining 257 have been retained for further examination, because they did not suffer from the limitations."

Some of the results, reported, are reproduced here.

	Total No Experiments	Exp with Sign Increase in yield	Exp with no sign. Increase in yield	Exp with negative response
Farm Yard Manure with or without artificials	72	52	44	4
Green Manure+Phosphates	10	80	20	—
Bone Meal ...	15	80	7	13
Phosphates .	17	65	30	5
Nitrogen+Phosphates	51	70	26	4

Crops experimented were paddy, sugar cane, cotton, tobacco, maize (jowar), wheat and jute. Most responsive crop was paddy and least responsive cotton.

The percentage increase of yield over control (5 years) and also the residual effect has been examined by Hendry[11] with the various types of fertilizers, farm yard manure or both for paddy in lower Burma.

[6] *Bone Products and Manures*, Lambart, 1930.
[7] *Minerals in Pastures*, J.B ORR., 1929, p. 112.
[8] Davis, Agricultural Research Institute, Pusa, *Indigo Publication Bull.* No 1, 1918, p. 5.
[9] Royal Commission on Agriculture in India, 1928, p 71, 72.
[7] *loc. cit.*
[9] *loc. cit.*

[10] *Proceedings of Board of Agriculture and Animal Husbandry in India*, Crops and Soils Wings, 1937, Appendix IIA.
[11] Hendry, *Agricultural Journal of India*, 1928, p. 359.

Some of the results obtained by Hendry are reproduced here.

Treatment per acre	*5 years manure* Per cent increase over average of controls	*5 years residual effect* Per cent increase over average of controls
Bone meal at 20 lbs P_2O_5	+26 5	+ 9·5
Superphosphate at 20 lbs. P_2O_5	+35 3	+15·3
Cattle manure at 30 lbs N	+37 5	+21·8
Cattle manure at 30 lbs. N+ Superphosphate at 20 lbs P_2O_5	+43 5	+27 6
Cattle manure at 30 lbs N+ Bone Meal at 20 lbs P_2O_5	+51 0	+31 8
Ammonium Sulphate at 30 lbs N+Superphosphate at 20 lbs. P_2O_5+K_2SO_4 at 20 lbs. K_2O . .	+33 5	+17·5

The results obtained with higher dosages of P_2O_5 are not available Yet the various figures give a rough idea that 100 lbs * of 20 per cent superphosphate would increase the yield by about one third of the yield already being obtained The soils where cattle manure is also used along with superphosphate have been found to give about 50 per cent increase in yield with about 30 per cent residual effect

Average yield[3] of rice for the year 1936-37 for all irrigated and non-irrigated area, from almost all parts of the country, is 988 lbs. per acre , and the similar yield for wheat is 811 lbs per acre

Fertilization at the rate of 150 lbs. superphosphate (15 per cent P_2O_5)[12] per acre is, therefore, expected to increase the yield of rice by 350 lbs. per acre and that of wheat by about 280 lbs. per acre An average figure for the increase of grains as 325 lbs per acre can be arrived (rice occupies 32 per cent[3] and wheat occupies only 10 per cent of the total cultivable area).

Thus the total number of acres that can be fertilized with 2,125,000 tons of bone superphosphate at the rate of 150 lbs. of 15 per cent superphosphate per acre is equal to 28,300,000 acres. An average increased yield of grains of 325 lbs. per acre would increase the yield on this acreage of land equal to 4,590,000 tons. This annual increase of grain production at the average rate of consumption of 14 ounces[13] cereals per day per person, can adequately feed thirty million additional people (or about twenty-two and a half million adult units).

	Million people	oz per day per person	Million oz per day
Children under 1 yr	15	0	0
Between 1 and 3 yrs	25	6	150
Between 3 and 10 yrs	80	10	800
Adult females . .	140	14	1,960
Adult males .	140	18	2,520
Total .	400		5,430

$$\text{Average per person} = \frac{5,430}{400} = 14 \text{ ozs. per day.}$$

And also the total requirement at the rate of 18 ozs per day per unit, gives $\frac{5430}{18}$ =300 million adult units

The whole contention in working out these figures, which though seem to be quite rough, has been that if the bone resources of the country are properly exploited for the manufacture of phosphatic fertilizers and if they are properly utilized for fertilization of the deficient soils , as many as *thirty million* additional people can be fed with the extra grain produced This figure is considered to be a very conservative estimate It may not be out of place to mention here that the maximum casualties[14] any time in India due to famine and consequent non-resistance to disease, have seldom been over 15 million.

The above figures do not indicate that all the bone superphosphate must be used for increased production of grains It is true that grains are essential for the mere maintenance of the population of the country, yet it is equally important that increased production should be secured for all food commodities which are essential for a suitably balanced diet. To make up these requirements in full, the production of various food commodities must at least be increased as follows.

Cereals .	by	10 per cent
Pulses	by	20 per cent
Fats and Oils ..	by	250 per cent
Fruits ..	by	50 per cent
Vegetables ..	by	100 per cent
Milk and milk products	by	300 per cent
Fish and eggs ..	by	300 per cent

* It should be pointed out, however, that due to low phosphorus content and high fixing power of most of our soils, the initial application may need to be as high as 500-750 lbs. per acre of 20% superphosphate for every 3 to 4 year period in order to get satisfactory crop response. Once the phosphorus content of the soil has been built up to an appreciable extent, the rate of application may then be reduced.

[3] *loc. cit.*

[12] Memorandum of the Development of Agriculture & Animal Husbandry in India, p 16, 1944.

[13] Memorandum on the Development of Agriculture & Animal Husbandry in India. The Advisory Board of the Imperial Council of Agricultural Research, p. 2 ,1944.

[14] Dutt, R. Palme. Problem of India, p. 125, 1942.

These figures[11] give an idea of the uphill task to be done and the importance of all fertilizers for this purpose

It should, however, be made clear that the calculations shown here are not meant to imply that phosphatic fertilizers alone are all important A balanced fertilizer application, comprising of organic matter, nitrogen, phosphorus and potash, does always give much better response than when phosphatic fertilizers are used alone.

The difficulties involved in translating this plan to reality are several. First, the present low price of the grains may not justify, in many cases, the use of superphosphate and bone meal, if the latter are beyond the economic reach of the farmers

Secondly, the high cost of sulphuric acid (due to limited sulphur resources in the country) may prohibit the manufacture of bone superphosphate, a product which is considered to be a better source of available phosphoric acid than bone meal Bone meal, because of its N content, has, however, an additional fertilizing value

The religious prejudice of most of the farmers may act as a hindrance to the use of bone products as fertilizers

All these difficulties coupled with many others can be melted into insignificance if the workers in the field give the plan of increased bone fertilizers production and utilization (modified if necessary) a real and enthusiastic support

On the overcoming of these difficulties depends to some extent the solution of problem of increased crop productions to which India looks today for the maintenance and proper growth of her starving millions

MEDICINE AND PUBLIC HEALTH

INTERNATIONAL MEDICAL ABSTRACT AND REVIEWS

We are in receipt of the first number (January, 1947), of this new journal of the Indian Medical Profession, containing abstracts of the new methods, diagnosis and treatment in medicine including specialities. In a foreward to this new enterprise, the editorial board has put forward the justification of publishing this monthly digest of current medical literature and progress of the medical sciences, reflecting all recent advances

For a single individual to keep abreast of the contents of over twelve hundred medical periodicals of American, European and Asiatic origin is impossible. Hence, the publication of this journal is fully justified. To solve the gigantic problem of disease and pestilence in this sub-continent, knowledge and application of the science and art of modern medicine, both preventive and curative, is essential. We have therefore much pleasure in welcoming the appearance of this new monthly, containing abstracts of current literature in Internal Medicine, Surgery, Obstretics and Gynaecology, Venereal diseases, Tuberculosis, Pediatrics, Opthalmology, Himatology, Pathology, Bacteriology and Dematology, and we hope it will fill a long felt gap in India's medical literature. The annual subscription is fixed at Rs. 12/- and correspondence to be addressed to the Editorial Office, Alipore, Post Box No 5, Calcutta 27

CENTENARY OF ANAESTHESIA

There are several dates of importance in the early history of anaesthesia, and the centenary of some of these has already been celebrated. The year 1946, marks the conclusion of a hundred years of uninterrupted progress since Morton in 1846, who effectively initiated the universal adoption of anaesthesia for surgical operations.

Inhalation anaesthesia which was developed in America and Britain, has remained virtually an Anglo-American speciality. The extension of inhalation anaesthesia carries with it the implication that the surgeon can not be responsible for the administration of the anaesthetic and the responsibility is shouldered by specialist anaesthetist. Anaesthesiology is the term to denote the wide range of the duties of the anaesthetist Recent developments in this science give ground for the belief that there is an increasing field for collective scientific work by chemists, physiologists, pharmacologists and the anaesthetists, and even the physicists have to play an important role.

In a special number of the *British Medical Bulletin* (Vol. 4, No 2, 1946), a historical account of the development of anaesthesia is reviewed, including also illustrated articles dealing with experimental and clinical aspects of the subject

In a special article on 'A hundred years of Anaesthesia' (*Ind. Med. Gaz.* November, 1940), it is stated. "In January 1845 Wells, with his partner Morton, demonstrated the administration of H_2O on a patient who came to have one of his teeth extracted The attempt failed, anaesthesia being most inadequate and the patient suffered considerably.

"Morton, however, did not lose faith and he continued his investigation with the possibility of producing anaesthesia by nitrous oxide and other inhalation vapours In 1846 he administered ether at the General Hospital, Massachussetts, on a man who was operated upon for a congenital tumour on the neck. The anaesthesia was an unqualified success. This is claimed to be the first surgery under general anaesthesia and credit must go to William C Morton . . ." Later in 1847, Simpson discovered the use of chloroform. Ether and nitrous oxide, the two first gaseous anaesthetics have retained their popularity and use despite the introduction of many other anaesthetics in recent modern times.

PHARMACEUTICAL INDUSTRY IN INDIA

S B SEN GUPTA,

MESSRS STANDARD PHARMACEUTICAL WORKS LTD., CALCUTTA

IN 1914, the essential drugs were seriously in short supply in Britain because of its dependance upon Germany Only a few firms were manufacturing synthetic pharmaceutical chemicals on a large scale and there was serious shortage of important drugs such as aspirin, phenacetin, phenazone etc. The British Chemical Industry set about remedying this difficulty and in a short time all the important drugs were available not only to the Army but also to the civil people and they could even supply synthetic local anaesthetics to Russia

India faced exactly the same situation during the World War II. Although great progress has been made in the sphere of biological products like vaccines, sera and antitoxins and in the manufacture of spirituous products, there was acute shortage of all essential drugs and medicines. The war has exposed clearly the poor state of our drug industry and our utter dependance on the foreign manufacturers.

The number of pharmaceutical concerns in India has considerably increased during the war but almost all of them have concentrated on the manufacture of common injectables, proprietary medicines, tinctures and extracts. No new line of production in which the country is deficient has been followed. As a consequence, we are still dependant upon foreign imports for our requirements of chemotherapeutic drugs, vitamins and hormones.

ALKALOIDS

Alkaloids occupy a very important, if not the most important, place in pharmacy. A large percentage of them is used to be imported before the war and although there is marked expansion in the production of alkaloid during the war, the industry is still in its infancy If proper steps be taken, the alkaloids would form a basic industry for export.

Strychnine is the only alkaloid produced on a large scale About 15,000 lbs. of strychnine are produced per year It leaves wide margin for export

The production of opium alkaloids, morphine and codeine, is absolutely controlled by the Government The yearly output of morphine and codeine was only 300 lbs. and 30 lbs. respectively before war and it was increased to more than 1000 lbs. and 300 lbs respectively during the war Even this increased output is inadequate to meet the demand

Quinine is the most important public health requirements of the country. Out of the country's requirement of 6 lakhs pounds, only 90,000 lbs are manufactured. It is surprising that inspite of such acute shortage in production, the Government has not taken any steps to increase the cinchona plantations nor has it allowed any private firm to take the possible steps The question of safeguarding India's quinine supply at reasonable price is the most vital one According to Hehir, about 100,000,000 cases of malaria are reported annually, thus causing serious economic loss to the country.

Emetine, one of the most important alkaloids, is not produced in India because of the non-availability of Ipecacuanha roots. Cultivation of Ipecacuanha is being tried in many places in India. Bal and his collaborators have recently studied the pharmacognostic properties of Ipecacuanha grown in Mungpoo. They have found that the total and non-

phenolic alkaloid contents reach their maximum in 3 years old plant and the values obtained are 2·5 per cent and 1·4 per cent respectively. The results are highly encouraging and efforts should now be made to cultivate this valuable drug scientifically and on a wide scale.

Caffeine was formerly imported from Germany and Holland where it was extracted from coffee. India, the main grower of tea from which caffeine could be obtained, had no caffeine producing plant before war. It is very encouraging to note that a few firms have already started to manufacture caffeins

Santonin was used to be imported from Russia before war. It is now produced in India but it is doubtful if the industry can stand the foreign competition.

Ephedrine, atropine, hyoscine are produced in small quantities.

NATURAL DRUGS

It has been found that the natural drugs produced in India can hardly cope with her own demand. The reason is that the cultivation of medicinal plants on a scientific basis has been carried out only in a few places. In Kashmere, a Research Laboratory under the most experienced guidance of Col Chopra has been established with the object of cultivating, utilising and standardizing valuable drugs Similar laboratories may be started by the Provincial Governments in all parts of India. Nilgiris, Cochin, Punjab, Assam, Sikkim are very rich in medicinal plants which require careful exploration. India is a country of varying climates and altitudes and whatever can grow elsewhere, can be grown in India India can thus not only be self-sufficient in her requirements of natural drugs, but she can achieve the position of an exporting country in drugs.

It may be mentioned that little authentic scientific information specially in regard to standardization is available of the wellknown drugs aconite, belladona, datura, cassia, colocynth, ephedra, lobelia, rheum, senega etc grown in different parts of India, and as such, no standard preparation could be made. Drs Sudhamaya Ghosh, J N. Ray, S B. Dutta and others carried out a large amount of systematic studies on the chemistry of indigenous drugs. It is a vast and one of the most complicated subjects. It requires more careful and exhaustive studies. Col. Chopra and his collaborators as members of the Indigenous Drug Enquiry Committee, under the auspices of Indian Research Fund Association, carried out a systematic pharmacological and clinical study of indigenous drugs. They tested the efficacy of drugs in the treatment of diseases commonly prevalent in India. They observed that none of the reputed drugs has any practical value in curing malaria. Studies in connection with treatment of amoebic dysentery have revealed that the bark of Holarhenna antidysenterica (kurchi) is a very effective curative. This drug is well tolerated, easy to take and its toxicity is low. No satisfactory indigenous drug has been found for the treatment of Kala-azar and filariasis—the two very prevalent diseases in India A few of the indigenous drugs showed efficacy as anthelmintics. However, it appears that most of the indigenous drugs have little or no therapeutic activity. Inspite of such discouraging results, many of the indigenous drugs such as Adhota vasica, Boerhaavia diffusa, Plantago ovata, Rauwolfia serpentina have been found to be very efficacious It is surprising that some of the reputed and much tried drugs like *Terminalia arjuna, Saraca indica, Abroma angusta* have been discredited as having no therapeutic value, and it is desirable that more exhaustive study should be made in this direction.

The whole field of indigenous drugs requires more exhaustive study from pharmacological, clinical and chemical standpoints Without these, no book of standards could be compiled and in India there is no such official book In U S A and in European countries, there are many standard pharmacopoeias, and medicines are manufactured according to the instructions given in them In India, there is no control nor there is any standard for the preparation of indigenous drugs Steps have already been taken to compile such books by following well-thought plans of foreign pharmacopoeia and it is gratifying to note that Indian Pharmaceutical List, 1946 has recently been out.

SYNTHETIC DRUGS AND RESEARCH

Pharmaceutical industry, during the recent years, has been profoundly affected by the great progress made in synthetic chemistry towards the conquest of diseases and maintainence of health. We should consider our contributions to the drug industry as old-fashioned and inepts in modern needs.

The introduction of synthetic drugs has brought a closer relation and co-operation between medical men, pharmacologists and chemists. Without the co-operation of pharmacologist, the toxic and therapeutic properties of a series of organic compounds of different groupings prepared by chemists cannot be worked out. By a long process of trials and errors it might be possible to alter the toxic properties of a certain member of a series without destroying its curative effect. The ideal drug is, of course, one which would perform its desired effect without any toxicity ; but this is an unrealizable dream because every drug is,

to some extent, a poison. Modern chemists, once they have discovered a compound with therapeutic properties, begin a long and laborious search for compounds with some changes in structure which can be modified and resynthesized until somekind of compromise is obtained between undiminished curative and diminished toxic actions with simultaneous studies of pharmacological and clinical properties of the compounds.

There was a time when doctors used only the old drugs and were afraid of trying medicinal chemicals prepared in the laboratory. It has recently been appreciated by the doctors that the chemical substances prepared in the laboratory are of the same nature clinically as that of natural prototypes like adrenalin, ephedrine and vitamins. These synthetic drugs may substitute natural drugs or, in some cases, may be more potent than or superior to natural drugs, as has been the case with atebrin, plasmochin, stilbestrol, and some time, after laborious testing of pharmacological properties, they may prove to be valuable remedies such as arsenicals, sulphonamides, barbiturates, vioform, and penicillin have turned out

Only a few firms in India manufacture atoxyl, carbarsone, sulpharphenamine, urea stibamine, vioform in limited quantity and no other chemotherapeutic drug is produced Excepting natural adrenalin and pituitary, no hormone and none of the vitamins are manufactured in India. Such is the deplorable condition of our pharmaceutical industry!

We have efficient scientific and technical personnel. We have got several government and semi-government industrial research institutions and we could not make headway, even during this opportune time of war, in the manufacture of important synthetic drugs, hormones, and vitamins. It is true that due to lack of basic chemicals and intermediates of coal tar origin as also lack of equipments, no development was possible in pharmaceutical industry. But the question is—"who will develop the basic chemical industry in India"? The Government's attitude is quite clear and it is absolutely useless to depend on the Government It remains for the capitalist to take up this industry. It is probable that most of the projects in basic chemical industry will attain profitable operations after many years and a few projects will quickly show the sustained profits. The dye business of Du Pont Company of U. S. A. was operated for six years before any profit was shown Synthetic ammonia and its related business were run at a loss for more than seven years. These are not hopeful pictures for capitalists but, we must create goods for the future and there should be an incentive to the necessity of hardwork and to the immense task and financial risk of developing basic chemical industry in India.

Plenty of coal tar is available in India ; only a small portion of it is distilled at Bararee Coke Company, Shalimar Tar products, Bengal Chemical and Pharmaceutical Works Ltd. and at Tata Iron and Steel Co Ltd. for recovery of benzene, naphthalene and creosote. Napthalene is used as insecticide ; light creosote is used for manufacturing disinfectants and heavy creosote is sold as wood preservatives. Many valuable basic organic substances such as toluene, pyridine, carbazole, creosote, authracene etc which are the starting materials for the manufacture of dyestuffs and drugs are not separated by suitable distillation The starting of coal tar industry together with dyestuff industry will be a very adventurous project and may have to be operated with much difficulties for many years but this huge industry will engage many people, both skilled and unskilled, and will, certainly, increase our natural wealth

Raw materials containing phosphorus is available abundantly, but excepting one small pilot operating at Indian Institute of Science, Bangalore, there is no phosphorus plant , and the cost of manufacture is too high there. The chlorides and oxides of phosphorus are very useful basic materials for synthetic drugs, so also metallic sodium which could be produced at Tata Chemicals Ltd. by installing one small plant

Rectified spirit is the only product which we obtain from fermentation of molasses but a lot of useful products could be obtained, if proper steps could be taken.

Synthesis of finished drugs from available raw materials requires special knowledge and technique. The various methods of preparations described in literatures, are mostly uneconomic, conflicting and sometimes are unpractical and misguiding It is therefore essential for every research worker engaged in pharmaceutical concerns to work out the best method and conditions for obtaining the maximum yield of a product. Every research institution should carry out these investigations in a well planned and co-ordinated manner. Unless these are worked out now, we shall be in the same deplorable position in future as we had been before the war.

Every industrial organization in U. S. A. and in European countries has research laboratory for carrying out both developmental work as well as the basic research work for finding out new products and in improving old ones. In India, there is practically no research laboratory in any industrial concern. Either the Indian capitalists do not appreciate the value of research in future expansion of industry or they think that spending money in researches is not paying Assuming a well trained staff, the impact of management policies is an important factor, because many of executives want definite results within a definite time

or cost and there are many who fail to see the continuance of long research with large number of staff when very little is forthcoming over a long period of time. Industrialists should bear in mind that successful industrial research creates new industry and more jobs for the people and brings more money.

Research has been firmly established as an essential activity of successful industry. No longer there is a question whether research should be done or not. The real question will be what lines of research—what specific problems—are to be undertaken. A large number of synthetic drugs has been put into market by foreign manufacturers. It is unnecessary to try to manufacture all of them. Only a few vitally important drugs are to be selected and their conditions of preparations from available raw materials are to be found out. In the following is listed the essential drugs without which a countrys' need for medicines cannot be met fully.

1. Antiseptic and disinfectants.—(a) Phenol, (b) Acriflavine and (c) Iodine.
2. Antipyretics and Analgesics.—(a) Aspirin, (b) Phenacetin.
3. Sedative and Hypnotics.—(a) Barbiturates of veronal and luminal type.
4. Antiprotozoal and antibacterial.—(a) Atoxyl, (b) Sulphar-phenamine, (c) Ureastibamine, (d) Vioform, (e) Mercurochrome and (f) Carbarsone.
5. Local anaesthetics.—Novocaine.
6. Antimalarial—Atebrin.
7. Sulphanilamide and its useful derivatives.
8. Endocrine Preparations.—(a) Oestrone, (b) Stilbestrol.
9. Vitamins.—all.
10. Antibiotics.—Penicillin.
11. Miscellaneous.—(a) Camphor, (b) Coramine, (c) Cardiazole, (d) Calcium gluconate, (e) Glucose, and (f) Boric acid.

Other Pharmaceutical Chemicals and Materials

Potassium permanganate from Indian manganese ore, creosote from Indian wood distillation, chloroform, chloral hydrate, bleaching powder, glacial acetic acid, carbolic acid, cresylic acid, trichloro acetic acid etc., are now manufactured in India on fairly a large scale.

Liquid glucose is produced in certain quantity in India from maize starch but the price is so high that it would not be able to compete with the foreign product.

Oleum hydnocarpus—a vegetable oil is produced in Malabar and is used in the manufacture of ethyl ester of hydnocarpic acid which is used for treatment of leprosy.

The production of shark liver oil which is a good source of vitamins A and D to the extent of 10,000 to 15,000 gallons per year also satisfies the present demand.

State and Industry

In the United Kingdom, the British Chemical Manufacturers' as well as British Plant Manufacturers' Association play an important role in formulating and in guiding the policy of the State towards the growth and development of chemical industries. In the Government of India, officials and laymen make plans and programme for industrial development. The Department of Scientific and Industrial Research in Britain, play a very active part in the development of new chemical processes and improving the existing ones by directly helping the chemical manufacturers in all possible ways. Government owned research laboratories in India play very little active part in developing industries. They do not like to be guided by the industries concerned nor they wish to guide them. During the war time, these institutions went into open competition with the indigenous chemical and biological preparations instead of carrying researches in new lines.

Any State organizations whether in form of planning committees, research board, etc., should compose of men who are authorities on the industry concerned. But in forming boards, panels, committee, the Government always selects persons who have no knowledge about the industry. Even the Drugs Technical Advisory Board which has been formed for purpose of controlling the quality and standard of drugs, consists mainly of medical men and Government officials.

Recently the Government have adopted the policy of sending a large number of students and technical personnel to U.S.A. or U.K. for special training in specific industrial lines. Most of the personnel selected are students and professors who are having higher theoretical training in the foreign Universities. Practically none of them who have experiences in industry, have been selected. This policy of Government will never cause any real development in industry, rather it would cause more unemployment. Experienced technical personnel should have been selected and encouraged to receive the practical and special trainings in different industries.

The spokesmen of Government always declare that they support the industrial development in India

but the restrictions they have already imposed upon the industry and the policies they have been following, have clearly demonstrated the differences in their declarations and desires Governments' policies of bringing foreign consumers' goods into India market and refusal of import of important plants, mechineries and certain basic chemicals are extremely detrimental to the development of industry in India.

In U.S.A. and in European countries there are Pharmacy and Drug Acts which strictly control the manufacture, so that, there can be no understandard, spurious and harmful products Unfortunately in India, so far, there is no such control in the manufacture of medicines It is understood that the Drug Act which was passed in 1940 would come into force very soon. But uptil now, there is no arrangement for establishing chemical and drug testing laboratories. It is needless to point out that analytical control and testing of chemicals and galenicals require highly qualified and trained personnel Had the Drug Act been in force, the doctors could be sure of the uniform quality and standard of medicines prepared in our country and they would unhesitatingly recommend the use of indigenous medicines in preference to foreign medicines

The Government excise regulations are great handicaps to pharmaceutical industries. The indigenous spirituous products are subjected to all kinds of control from province to province, thus restricting the free movements of medicinal products The imported spirituous products enjoy a distinct advantage over the local products that they have unrestricted inter-provincial movement The duty on spirit in medicinal preparations is abnormally high. The public has to pay a duty to the State even when he is ill. The whole matter was referred to the Government without any result.

Dr P J. Thomas of the Government of India stated that one of the chief difficulties which the Indian Chemical & Pharmaceutical Manufacturers have felt is the high transport charges prevailing in India. As an illustration, he said that the freight from Orissa to London for Nuxvomica seeds is the same as the Calcutta manufacturers have to pay them from Orissa. The question of freight should be considered by the Government sympathetically.

Patent Right in Industry

Another obstacle to the development of pharmaceutical industry in India is the Indian Patent Law. It is difficult to understand how the preparations of important drugs, the chemical compositions of which are known, can be patented. As for example, if an unknown alcohol is oxidized to aldehyde by a known oxidizing agent, the step could probably be patented under the present law. But does the preparation of aldehyde involve any inventive merit? Many chemical patents are of these types and their validity is open to doubt.

It is also surprising that even the preparation of official or vitally important drugs, could be patented. The right for manufacture and sales of these important drugs are possessed by the foreign manufacturers As for example, the right for preparation of atebrin was leased out to certain American and British firms and Indian manufacturers have no opportunity to prepare atebrin—although India is predominantly a malarious country where quinine is extremely in shortage. Similarly the preparations of important drugs—sulphathiazole, sulphapyridine, sulphaguanidine—are already patented by May & Baker Even in extreme shortage of these drugs, during the war we had to depend upon the foreign manufacturers for supply. The fundamental patent laws are to be so constituted or modified that right for manufacture of vitally important drug should not be vested to certain manufacturers

Plants and Equipments

The pharmaceutical industry requires a few special equipments for carrying out different chemical operations step by step resulting ultimately to final production of drugs In small scale industry, these operations are carried out in glass vessels. Glass, manufactured in our country, suffers from the following defects:—

(*a*) lack of sufficient strength to withstand violent mechanical treatment ,

(*b*) liable to fracture when exposed to quick change of temperature ;

(*c*) too much soluble alkali in glass Many products in contact with alkali deteriorate in quality and this is a serious handicap to indigenous manufacturers.

Ceramic and stonewares have their large use in pharmaceutical industry These vessels should be free from porosity as far as possible to counteract the contamination.

Recently a Glass and Ceramic Research Institution has been established as a branch of Council of Industrial and Scientific Research to improve the existing technique of manufacture of glass, pottery, porcelain, enamels and refractories. It is a move in the right direction.

Next to glass vessels, enamelled iron and steel vessels which are good acid resistant have a wide field of use. The enamelled vessels manufactured in India cannot stand the strain of heat and strong acid for a long time and consequently greater number

of vessels are to be used—causing much uneconomy in the manufacture of drugs.

Metals are widely used in making plants and storing vessels Ordinary metals are susceptible to the attack of acids and alkalis which cause unexpected reactions and deterioration in the quality of products Stainless steel of high degree of corrosion resistance has found a large use in the pharmaceutical industry Unfortunately stainless steel of required standard is not available in India in sufficient quantity.

Basic processes involved in pharmaceutical industry consist mainly of (a) Percolation and Maceration, (b) Grinding, (c) Evaporation, (d) Drying and (f) Filtration.

Percolation is carried out in copper or in tinned copper percolator and maceration in stonewares

Grinding is carried out in high speed mills and in Ball mills—both are available in India

Evaporation is ordinarily carried out by steam heating or by direct heating under fire. Modern method of evaporation and concentration under vacuum has the advantages that it is economic, takes less time for completion of operation, and being less drastic in heat treatment, it keeps the quality of products good Vacuum pump of high capacity is not manufactured in India Only a few firms supply vacuum pump of low capacity but its working is not very satisfactory.

Drying is ordinarily done in steam or water bath or in hot air oven. Modern method of drum drying with vacuum has not been adopted as yet.

Filtration is usually done under suction through large funnels with filter papers or through cloth. Filterpress has not yet come into use

There are other minor operations such as stirring, emulsification, sterilisation in autoclave, tabletting, granulating which do not require complicated machinery.

Future of Indian Pharmaceutical Industry

Inspite of many defects and handicaps, the medicine manufacturers in India, have been able to create confidence and satisfaction in people and doctors, regarding quality of drugs. The idea of progress can be made from the fact that the total value of medical stores purchased in India increased from about 16 millions of rupees in 1938-39 to 35 millions in 1942-43. The import consequently, declined from 2·2 millions to 1·4 millions of rupees Inspite of such progress, there is the general belief that foreign made medicines are better. Many doctors, still, feel diffident in prescribing the indigenous medicines The reasons are many. One of the main reasons is that some manufacturers prepare understandard products—taking advantage of the fact that there is no Drug Act to control the manufacturers. Other reasons are the feeling of inferiority complex and lack of scientific knowledge in general public.

Gradually, people will know that aspirin, calcium gluconate tablets, emetine, morphine, glucose, calcium gluconate injectibles are manufactured from chemically pure substances, mostly imported and foreign products cannot be superior in quality The chemicals are used after rigorous testing and purification Doctors and public will gradually believe that indigenous medicines are all prepared, standardised and sterilised strictly according to official instructions and specifications. The defects that are sometime found in indigenous preparations, are accidental and may also be found in case of foreign products. The fear, doubt and complexes of people will gradually vanish and indigenous drug industry will have a bright future inspite of serious foreign competition

After war, there would be a general depression in trade As innumerable mushroom concerns have sprung up during the war, Indian pharmaceutical industrialists are not very optimistic about their future But even in depression, humanitarian in public health measures, may bring about a boom in the drug industry in contrast to slumps in other industries

On the otherhand, it is true that in prosperous time, though there would be less sick people, people will take better care of their health and also seek better medical advice more frequently. For this reason, drug industry in India will have a better future

Prosperous homes are boon to faddists and the demand for advertised medicines, specially the proprietary medicines will be as much or more than the ethical medicines "Patent medicine habit" is not easily broken and with greater prosperity, the proprietary medicine industry may enjoy a booming period

The modern practice of exaggerated advertisement of proprietary medicines should be given up. With the advancement of education, the public will learn that these advertisements, which make them unnecessarily conscious of diseases, are having no value from scientific standpoints. The public will understand that the claims made in the advertisements lead them to postponing seeking skilled advice and thereby, prejudice the success of proper treatment. Advertisement of medicines should be different from the advertisement of other goods. Personal harm may result from exaggerated, misleading or

unwarranted claims and in future high standard of advertisement is to be adopted.

It is also true that in a prosperous country, one would expect to find less malnutrition, better housing and employment conditions all of which will lessen the demand for medicaments. But, India will take long years to attain this condition

At all times, there will be thousands of human beings who will be in unsatisfactory health from birth and some period after, who may be unaware of the facts and may remain so. Of course, as the standard of living rises, more people will be conscious of improvement possibilities and as a consequence, there would be a demand for specialised medicinal preparations.

And with the growth of hospitals, sanatorium and clinical and diagnostic centres, the demand for medicines will no doubt increase.

BOOK REVIEWS

Trees of Calcutta and its Neighbourhood—By A. P. Benthall. Pp. cii + 513 with 274 illustrations Published by Thacker Spink & Co. (1933) Ltd, 3, Esplanade East, Calcutta, 1946. Price Rs. 25

Lack of local floras in India is a serious handicap not only to the botanists but also to the amateur naturalists. Since the beginning of the nineteenth century, a band of brilliant systematists, have worked out the provincial floras. The first serious attempt to provide a *Calcutta Flora*, was made by Masters in 1840 (*Trans Agri. Hort Soc. Ind*, 7), and a century has elapsed before we could get an up-to-date account of this area Prain's 'Vegetation of the Districts of Hughli-Howrah and the 24-Pergunnahs' (*Rec. Bot. Surv. Ind.* 3, 1905) served the purpose for sometime, (when read along with his *'Bengal Plants'* 1903) but unfortunately both the books are now out-of-print for more than two decades. Besides, the provincial boundary of Bengal was revised in 1911, and Bihar and Orissa separated out Bihar and Orissa soon after (1925) published an account of the flora of the new province. But much to our regret Bengal is without any flora of its own. Hence the publication of this book will to a great extent remove this gap Although primarily intended to cover the area round about Calcutta only, it will be found that the book includes the great majority of the trees to be found in the valleys of the Ganges and Brahmaputra, and hence it could be used as a reference for visiting botanists, students and amateur naturalists in Bengal.

The book includes both wild and planted trees and a 'key' is provided based on such obvious characters as shape and size of leaves, colour, size, and shape of flowers etc.

An analysis of the trees give us an indication of the origin of the flora of Calcutta. Of the 276 plants described, 69 may be considered as native or naturalized in the area, 91 are indigenous in other parts of India, 50, though not natives of India are indigenous in Asia, 14 are natives of Africa, 42 of America, 9 of Australia and 1 of South sea islands

The author, an amateur botanist, has done a signal service to the cause of advancement of botanical studies in the province. The description given under each genera and species is exhaustive and full of information ; the numerous illustrations and the introduction are excellent.

The publishers deserve mention for the neat print and presentation, in spite of numerous restrictions on the press.

But for a few mistakes in printing and controversial mythological and religious belief ascribed to the species described, the book is an admirable production in India's botanical literature and deserve a large circulation in the libraries of the botanical institutions of India and elsewhere.

A. K G.

Raw Materials from the Sea—By E. Frankl and Armstrong, F R.S., and L. Mackenzie Miall, B.A Illustrated. Published by Constructive Publications Ltd., 152, Upper New Walk, Leicester, England. Pages 1—164. Price 15*s*.

The senior author (Dr Armstrong) who died last year was trained in Germany by Emil Fischer and van't Hoff, who initiated Dr Armstrong to the methods of extraction of pure chemicals from oceanic or sea salt deposits. In this publication the authors have carefully described the important methods of preparing common salt, potassium chloride, potassium sul-

phate, borax, boric acid, bromine, iodine and magnesium metal and its salts lithium compounds and drinking water from sea water and deposits from sea occurring in different countries. Due to its use in air crafts, there has been a tremendous development of the manufacture of metallic magnesium in recent years. The working of the deposits from the Dead sea is being pushed on an industrial scale by the Palestine Potash Co. and other deposits in Alsasce, Germany and different parts of U.S.A. have also been considered. In the first two chapters a picture of the different ingredients in sea water has been drawn. This is an exceedingly useful and timely publication, but the price appears to be rather high. The following lines about common salt, specially the last line are specially interesting to the Indian readers:—

"Nations have grown prosperous through it, wars have been fought over it, highways by land and sea have been developed to carry it. Most countries have laid it under tribute, and people even to our own times have rebelled against the burden of the salt tax." (page 63).

N. R. D.

The Periodic Partial Failures of American Cottons in the Punjab. Their Causes and Remedies— By R. H Dastur. Published by Indian Central Cotton Committee, Bombay. Price Rs. 5/8/-.

The results which have been published from time to time in different papers in the *Indian Journal of Agricultural Science,* have been brought together and embodied in the present volume. It is a very useful publication for those who are interested in cotton cultivation in India, and can have all the facts on the periodic partial failures of American cottons in Punjab popularly known as "Tirak". The symptoms of Tirak are—the premature cracking of bolls with immature seeds and poor quality of lint This is preceded by a yellowing and reddening of leaves, towards the beginning of the reproductive phase and early defoliation. These symptoms are not found in indigenous varieties of cotton and is significant for the fact that American varieties are gradually replacing the indigenous varieties and partial failures entail a heavy loss to the cultivators The investigations began in 1935 under a scheme financed by the Indian Central Cotton Committee and supported by the the Punjab Government The series of investigations were completed in 1943 and the significant contribution which Prof. Dastur has made is a striking example of how the results obtained in plant physiological investigations on crop plants can be successfully utilised in the advancement of agricultural practices of far reaching economic importance. The monograph has been divided into twelve chapters dealing with the various factors responsible for the physiological disturbance in the plant leading to partial failures as for instance the effect of different soils, the effect produced in the metabolism of plants of the Tirak-affected crop and the remedial measures.

It was found that Tirak was caused in crops growing both in light sandy soils deficient in nitrogen and also in soils with saline subsoil. But the symptoms showed by the leaves of Tirak-affected plants on the two soils were found to differ. In case of soils with saline subsoils there was no yellowing of leaves prior to shedding as was the case with leaves suffering from nitrogen starvation. The chemical changes produced in the Tirak-affected plants were found to be the high accumulation of tannin content in the leaves and low potassium content in the bolls associated with immature cotton seeds in both the soil types. Deficiency of potash in Tirak-affected plants on the two soil types have been explained to appear in two different ways. On light sandy soil the uptake of potassium was lessened on account of a deficiency of nitrates in that soil and on soils with saline subsoils the deficiency developed on account of the physiological drought that interfered with the absorption of nutrients of which potash was one. The remedies suggested were firstly June sowing instead of general May sowing The delayed sowing was found advantageous in curtailing unnecessary vegetative growth and in not exhausting the soil nutrients at the time of reproductive phase, when they were most needed and thus the equilibrium of the crop was not upset The June sowings were found to be better adapted to its environment than the May sowings. Secondly manuring the deficient soils with nitrogen fertiliser and thirdly irrigating the soils with saline subsoils when the symptoms appeared Due to wide spread heterogeneity of the Punjab soils no general application of the ammonium sulphate fertiliser could be recommended but the "Tannin Test" may usefully serve as guidance in this respect.

B. K. K.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

GROWTH OF JUTE PLANTS AND THE CHANGES IN THE WORK OF RUPTURE OF THEIR FIBRE

It is common knowledge that the plants which supply jute seeds, are not retted for fibre of commerce. This is due to the fact that over-mature plants produce poor quality of fibre which is stiff, brittle and possess low extensibility. In order to record the changes that are brought about in the fibre in course of the growth of the plants and also to determine by fibre-testing method the best time for harvesting jute, an experiment of preliminary nature was conducted at the Bose Institute, Calcutta, in 1941-42. Seeds of *Corchorus capsularis* (D. 154) were sown on 20-6-41 and later on weekly samples of 20 plants each of average height were collected from the 5th to the 19th week and stripped of their fibre after careful retting. The fibre samples were subsequently dried and weighed for yield. The ballistic work of rupture on these fibre samples were found at the Jute Technological Laboratories of the Central Jute Committee at Tollygunge, and in this connection our thanks are due to Mr C. R. Nodder, the Director and to Dr K. R. Sen, the Senior Research Physicist for their help The samples during fibre test were conditioned at 80°F and 75 per cent R.H. for several days before actual testing started. In each case, a test sample was obtained by cutting off a length of 36 cms. from about the middle of the bundle of reeds (keeping the root-ends on a common line). The sample so derived was then mixed up to make the bundle homogeneous as far as possible. The test bundles of jute were prepared from this sample by weighing out 100 mgs in each case after submitting them to a standard combing treatment. The testing was carried out on the Ballistic Fibre Tester over 10 cms. test length The results obtained are given below. It may be mentioned here that the samples at the 13th, 17th and 18th week could not be collected for unavoidable reasons. The first flush of flowers appeared in a few plants on 11-9-41 (about the 12th week).

The results given in the table will show that the work of rupture (which involves both strength and extension) of the fibre increases with the growth of the plant upto the 12th week (which was approximately the time for flowering and also branching of the tips of plants). This condition prevailed for about three weeks after which a deterioration in the quality of the fibre set in. The work of rupture of the fibre obtained from plants of the same age is about the same irrespective of the height of the constituent plants. This became evident from the two sets of plants gathered after the 12th week, one of which

TABLE I

WEEKLY GROWTH RECORDS OF JUTE PLANTS AND THE TECHNOLOGICAL RESULTS OF THEIR FIBRE

Weeks	Av height cm.	Total wt of bundles gms	No of test bundles	Ballistic work of rupture with s e. (arbitrary units)	R.H %
V	37·4	1·6	10	5·3±0·52	76
VI	47·8	3·1	25	5·2±0·45	75
VII*	72·8	7·3	25	10·6±0·50	73
VIII	78·4	8·5	30	7·8±0·43	74
IX	81·5	9·0	30	6·6±0·25	75
X	88·5	10·0	30	6·4±0·29	73
XI	120·0	20·3	30	6·2±0·34	75
XII	130·0	24·0	30	8·6±0·42	74
XIII	.			.	.
XIV	120·0	15·5	30	8·4±0·37	70
XV	161·0	35·8	30	8·5±0·41	76
XVI	133·0	23·7	30	7·1±0·33	69
XVII	.	.	..	.	...
XVIII	.		.	..	...
XIX	.	82·1	30	5·4±0·33	78

* The fibre in this sample was very coarse to the touch due to incomplete retting

had 90 cm as the average height, while that of the other was 170 cm and their Ballistic Work of rupture was found to be 8·4±0·31 respectively.

The author is grateful to Dr D. M. Bose, Director of the Bose Institute, Calcutta, for the interest he took in this work.

J. K. CHOUDHURY

Bethune College,
Calcutta, 18-12-1946.

A PRELIMINARY NOTE ON THE GRASSLANDS OF THE JUBBULPORE DISTRICT, CENTRAL PROVINCES

GRASSLANDS, within recent times, have gained great economic importance. To sustain pressure of population on land, grasslands have been brought as much as possible under agriculture and constitute some of the finest granaries of the world as also of India. But grass plays a very important part in live-

stock and dairy industry. Lately grass has become an important raw material for paper, straw board and other industries and as such it is already being employed on a large scale in the paper mills at Jagadbri in the Ambala district of the Punjab, at Saharanpur in the United Provinces, etc Likewise, various types of grasses are employed to a very large extent as raw materials in the Strawboard mills at Saharanpur and Meerut in the United Provinces. Recently, the author observed extensive unknown glasslands near the Madan Mahal hills, near Jubbulpore and this note has been written to draw attention to their economic possibilities These hills are best approached from the small town of Garha-Purwa situated on the Jubbulpore-Shahpura Road. The village of Purwa is situated almost on the fringe of a large mass of granite, which is crowned by an ancient monument known as Madan Mahal which was built by the Gond King, Madan Singh The hills in the neighbourhood of Madan Mahal are a little above 1,500 feet to about 1,600 feet above sea level. The Madan Mahal Hill commands a fine view of the neighbouring granite country. Standing here the author saw an extensive savana or grassland. It was observed that this grass grew very thickly on these granite hills, even where there was little soil, while in the intervening lower ground and particularly in the valleys one continuous and large expanse or rather a sea of grass was to be seen The author visited the area in December, when the grass had dried with a beautiful yellow hue The grass was about three feet in height. Looking eastwards from Madan Mahal the broad valley, which further north forms the Omti *Nala*, was densely overgrown with this grass. This valley in its upper reaches is three-quarters of a mile in width but lower down it broadens up. This valley near its source almost links up with the valley of another stream which runs westwards and debouches on the western side of this granite mass near the village of Sagra (23° 8′ 10″: 79° 52′ 30″). It is noteworthy that this grassland is not confined to the granite hills but it was also observed occupying the flat alluvial ground between Purwa and Lamehta Ghat and Tilwara Ghat. The flat-topped hills of the Deccan trap across the Narbada are also covered by long grass but unfortunately the grass is burnt from March until the advent of rains. Similar grasslands were also observed in the neighbourhood of Katni covering the Vindhyan rocks These grasslands were also observed in the Rewa territory as also farther north. Thus it would seem that these grasslands are quite extensive and it would be certainly worth while to develop them. It is also alleged that the best agricultural soil has developed under grassland conditions. Of course grasslands elsewhere have been generally converted into good granaries.

The position of these grasslands, where first observed near Madan Mahal hills is almost on the Tropic of Cancer, (lat 23° 10′; long. 79° 55′). The average annual rainfall for Jubbulpore is 53 6 inches. The lands, farther north lie above the Tropic of Cancer.

In the neighbourhood of the mass of the Madan Mahal granite there are a number of large storage tanks for example Gangasagar, etc. and with a little effort by way of pumping, etc., these could provide excellent irrigation. It may also be noted that the Narbada flows immediately to the south of this area It was observed that on the recent alluvium on the sides of the channel of the river during the low water season, almost every inch of the ground was occupied by cultivation and the *rabi* crops were seen to be flourishing. Similarly, with irrigation provided by the river, intensive cultivation could be carried on in the adjoining land where the alluvial soil is quite suitable

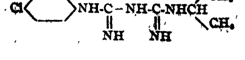
Apart from the conversion of these grasslands into arable lands, the resources of grass appear quite extensive and it should be found out how much surplus grass, after meeting the local requirements, could be available for industrial purpose. But simply destroying an industrial raw material in great demand by burning, shows bankruptcy of thought in the utilization of the natural resources of the country With a hope of making certainly better use of this commodity the attention is drawn to the potentialities and possibilities of these grasslands. Apart from other needs and uses a large quantity of grass is even required for the vast cattle population of the country It has also been proved by experiments that the cutting of grass, twice or thrice a year produces greater yields than a single cutting at the end of the grazing season. It is familiar that if grass is not cut or is permitted to rot, its quality and quantity degenerate in a few years. The grasses from the sub-montanne forests of Saharanpur etc. are now collected as noted already, and the grasslands in question could be utilized and improved with great benefit.

H. L. CHHIBBER

Department of Geography,
Benares Hindu University,
Benares, 4-7-1946.

A NOTE ON THE PREPARATION OF PALUDRINE

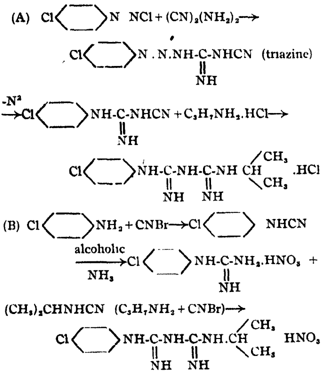
PALUDRINE,[1,2] the latest synthetic antimalarial discovered in the research laboratories of the Imperial Chemical Industries, London, is N^1-*p*-chlorophenyl-N^5-isopropyl-biguanide (I).



(I)

The drug has already shown very encouraging results in clinical trials[3-6]. Its advantages[1,7] over mepacrin and quinine are its prophylactic property, its non-toxic nature and enhanced antimalarial activity.

On account of the importance of Paludrine as an effective anti-malarial, it was thought of interest to establish the experimental conditions for its preparation according to the following two schemes[2,7,9]



At the time we undertook the work, the experimental details by Curd and Rose[2] were not available to us. We have obtained Paludrine hydrochloride m.p. 241°C by heating isopropylamine hydrochloride with *p*-chlorophenylcynoguanidine at 140-150°C for 6-8 hours and extracting the product with hot water Following the original method of Walther and Grieshammer[8] (15 g. of the triazine gave 4 g. of denitrogenated product while 8 g. of triazine remained unchanged). Curd and Rose[2] have effected the denitrogenation of the triazine in 55 per cent yield calculated on $ClC_6H_4NH_2$ using β-ethoxyethanol We have effected the denitrogenation in 45 per cent yield by using either acetone or alcohol

Das Gupta *et al*[9] prepared Paludrine nitrate according to scheme (B). As no details were given for the preparation of *p*-chlorophenylcyanamide and isopropylcyanamide, we have established the same for their preparation. *p*-chlorophenylcyanamide, m.p. 101°C, was prepared by the action of cyanogen bromide on *p*-chloroaniline in absolute alcohol using potassium bicarbonate in good yields (83 per cent), and isopropylcyanamide was obtained in good yield by the action of cyanogen bromide on isopropylamine in ether We have successfully prepared paludrine nitrate, m.p. 158-160°C, according to scheme (B).

On comparison of the two methods detailed above, we find that method (A) is more convenient and gives comparatively better yields

Full details will be published elsewhere.

Further work on substituted biguanides as possible antimalarials is in progress

H. L. Bami
B. H. Iyer
P. C. Guha

Organic Chemistry Laboratories,
Indian Institute of Science, Bangalore
8-11-1946

1 Rose, *Endeavour*, 5, 65, 1946
2 Curd and Rose, *J. C. S.*, 729, 1946
3 Das Gupta *et al*, *Ind. Med. Gaz.*, 80, 241, 1945
4 Davey, *J. Board of Sci. & Ind. Res.*, 4, 660, 1946
5 Anon., *Lancet*, 1, 288, 1946
6 Anon., *Lancet*, 2, 639, 1945
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8 Walther and Grieshammer, *J. fur Prakt. Chem.*, 92, 251, 1915
9 Das Gupta, Gupta and Basu, Science and Culture, 11, 304, 1946.

A NOTE ON STARCH IN *MIRABILIS JALAPA* SOLUBLE IN COLD WATER

Starches are well known to be varieties of polysaccharides having empirical formula $C_6H_{10}O_5$ and occur in nature in very many different forms with different properties, some giving yellow colour with iodine and others not giving any iodine reaction, while, ordinarily, starch gives the well known characteristic blue colour with iodine, the colour being discharged on heating and reappearing on cooling.[1] Starch $(C_6H_{10}O_5)_n$ on hydrolytic degradation generally yields a hexose It is formed in the cells of many plants as granules and constitutes in some form or other the staple food. Its easy hydrolysability by dilute acids or enzyme action in the living animal system gives it the special food value. When starch granules are heated with water, they swell up and burst at 50°C and partially dissolve in water with characteristic appearance, known ordinarily as starch paste, leaving an insoluble portion ; and from the starch paste, alcohol throws down a white powder, technically known as soluble starch The starch granules as such, however, have hitherto been found to be insoluble, and no suitable solvent for it has been found to enable determination of molecular

weight of starch granules and structure of this fundamentally important complex carbohydrate

The author has obtained a variety of starch from the fruits of *Mirabilis jalapa* (Fam Nyctaginacoae) soluble in cold water and insoluble in alcohol and acetone Some mature black fruits were collected and fried at about 60°C-75°C when the fruits burst giving a white light product The white product completely goes into solution in cold water at room temperature (28°C) on shaking, imparting the characteristic appearance of starch paste to the water. From the solution, alcohol or a mixture of alcohol-acetone throws down a white substance which, under the microscope, is found to be porous, amorphous and fibrous aggregate. The study of this substance is proceeding.

The solution in cold water is filtered through Carl and Schule's quantitative filter paper ; and the filtrate is tested with iodine, (after making blank experiment with water through the filter paper). A drop of iodine gave a deep blue colouration which is discharged on warming but reappears on cooling. Another portion of the filtrate is boiled with dilute hydrochloric acid and treated with Fehlings' solution, giving yellow precipitate A third portion of the filtrate being boiled with dilute sulphuric acid responded to the Benedict's reaction

Having thus seen that the aqueous solution contains starch and the relation of the complex starch molecule to hexose being known, the starch molecule must naturally contain a very large number of hydroxyl groups. Without proceeding with the solid starch isolated from the cold aqueous solution as the process of its extraction might bring about any molecular or structural change, the benzoyl derivative is prepared direct from its solution in cold water without warming.[2]

To 5 c.c. of the starch solution is added about 10 c.c of Merck's extra pure benzoyl chloride and the mixture shaken ; and to this added freshly prepared cooled solution of caustic potash until the solution becomes alkaline The mixture is shaken well without warming, stirring the side of the test tube with glass rod A heavy oily substance is formed which gradually turns butter-like. The mixture is repeatedly washed with water until free from alkali and chloride and benzoate, and allowed to stand in contact with cold water when the substance is obtained in white crystalline form. It is filtered, pressed between quantitative filter-papers and dried in $CaCl_2$—dessiccator. Soluble in benzene, alcohol and more readily in chloroform. M.P. 118°C.

From further work with the substance which is in progress, it is expected to arrive at a molecular formula of starch present in the fruit of *Mirabilis jalapa* and its provisional structure.

I am indebted to Dr D. Chakravarti, D.Sc. of the University College of Science and Technology, Calcutta for encouragement for following up the work.

T. C Chaudhuri

Pabna (Bengal),
10-11-1946.

[1] *Ber.*, *25*, 1237; *27*, 1293; *28*, 385, 783.
[2] *Ber.*, *19*, 3218; *21*, 2744, *23*, 2962; *27*, 2545 Schotten-Baumann, with slight modification.

CHEMICAL INVESTIGATION OF THE SEEDS OF *SWIETENIA MACROPHYLLA*, LINN

The dried, decorticated, powdered and defatted seeds on extraction with petroleum ether gave a pale yellow gummy solid from which by ether extraction a bitter principle was separated from an insoluble non-bitter The latter on crystallization from acetic acid melted at 256°C (decomp) The bitter gum was separated into two fractions by treatment in alcoholic solution with $Ba(OH)_2$ which threw down an insoluble gummy Ba salt. From the soluble portion by acidification was isolated the bitter substance which after repeated crystallization from dilute acetc acid gave diamond shaped crystals m p. 183-84°C (decomp.).

The non-bitter (yield 1 to 1·2 per cent) $C_{18}H_{24}O_5$, was optically active $[\alpha]^{30}_D = +133°·5$ in 4·25 per cent chloroform solution. It gave negative test for aldehyde, ketone or glucoside group, but positive evidence of MeO –, OH, and lactone group. A positive reaction with Tollen's reagent indicated an unsaturation in the $\beta\gamma$ position to the lactone ring

The hydroxy acid was also bitter The OH group in the non-bitter was inert and did not react with acetic anhydride or phenyl isocyanate On dry heating, it gave off H_2O and CO_2 It could not be reduced by Adam's platinum catalyst, but gave a dibromide and decolorised hot $KMnO_4$ solution with Hg acetate in acetic acid a dehydro compound and an acetoxy mercuric derivative were isolated. Zinc dust distillation in a current of hydrogen yielded at 250-320°C a yellow gummy product with a terpenaceous odour. At 320-370°C a brown oily liquid was obtained which gave a picrate, m p 117-118°C

The non-bitter did not give colour-change with Rosenheim and Kohlenberg reaction, but a yellow colour with Rosenheim and Callow's and Liebermann Burchardt reactions Salkowski's reaction gave a deep yellow colour changing to brown.

The bitter, $C_{13}H_{22}O_5$ (yield 0·8-1.0 per cent) crystallised in diamond-shaped crystals m.p. 183-184° (decomp.) and was active, $[\alpha]^{30}_D = -82·4$ in 2·4 per cent benzene solution. It also gave negative test

for glucoside, aldehyde and ketone groups but positive test for OH and OMe groups and also an unsaturated lactone group. The oxy acid reverted quickly to the lactone Acetylation was not successful. Drastic conditions only changed the colour to yellow and brown and a green fluorescence appeared Hydroxy coumarin ether group was also absent.

On reduction with zinc dust and alcoholic HCl a neutral product m.p. 180°C was obtained. NaHg gave an acid product. A tetrahydro derivative m p 174-75°C was obtained on catalytic hydrogenation $KMnO_4$ oxidation gave a neutral product m p 145-50° Reaction with Hg acetate gave a dehydro compound, and a diacetoxy mercuric compound

Rosenheim reaction gave a pink, Kohlenberg's reaction, yellow to orange, Rosenheim & Callow's reaction a red, Salkowski's reactions an orange to deep red and Liebermann-Burchardt reaction yellow to orange colour, the last with a green fluorescence

The determination of MeO-group gave consistently low results due to much resin formation On distillation with zinc dust a hydrocarbon was obtained which gave a small amount of a picrate

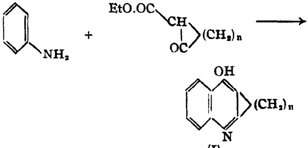
Further investigation is in progress

TARAKESWAR CHAKRAVORTY
S. S GUHA SIRCAR

Chemical Laboratory,
Dacca University,
Dacca, 25-11-1946.

4-HYDROXY QUINOLINE DERIVATIVE AS PROPHYLACTIC ANTIMALARIAL

THE major problem in therapy of malaria is how to prevent relapses in *p vivax* infections and it is now believed that these relapses are due to the persistence of exo-erythrocytic forms of the parasite which are not affected by the common antimalarial drugs. As such, research is being continued for finding out a drug which may serve as a true prophylactic Amongst the various types of compounds that might be found effective in the prevention of relapses, 4-amino quinolines are being noticed to be of special specificity (*Cf.*, Basu[1]). These products are generally obtained from 4-hydroxy quinolines, and it is being reported that the latter also when substituted particularly in 2 and 3 positions by alkyl groups, exert a prophylactic action on the sporozoite infection in avian malaria. It is, accordingly, being considered to be of interest to study the characteristics of the above type of 4-hydroxy quinoline derivatives that are substituted at the 2 and 3 positions by *cyclo*-polymethylene chain. Such compounds might be easily synthesised from the following reaction between an appropriately substituted aromatic amine and a β-ketonic ester that might be obtained from cyclohexanone, cyclopentanone or cyclo-butanone (*Cf.*, Sen and Basu[2]):



(I)

It is known[3] that the compounds of the type (I) when n=4, exert an anaesthetic property but no appreciable antimalarial activity Still derivatives of the above nature have now been prepared by condensing *cyclo*-hexanone-2-carboxylate with amines like m-chloraniline, m-anisidine and m-aminobenzoic acid, and similar other products from *Cyclo*-pentanone and *cyclo*-butanone-2-carboxylate are being synthesised in order to study their effect in inoculation malaria, as well as, in mosquito-transmitted malaria infection

U P. BASU

Bengal Immunity Research Laboratory,
Calcutta, 15-12-1946

[1] Basu, SCIENCE AND CULTURE, *12*, 145, 1946-47
[2] Sen and Basu, *Jour Ind. Chem Soc*, *7*, 435, 1930
[3] Magidson, Private Communication

A NOTE ON THE DEVELOPMENT OF THE EMBRYO-SAC AND ENDOSPERM IN *ALANGIUM BEGONIAEFOLIA*, ROXB. (=*MARLEA BEGONIAEFOLIA*, ROXB)

Alangium begoniæfolia, Roxb (=*Marlea begoniæfolia* Roxb)[2] is a medium-sized tree found scattered in the outskirts of the Dacca city.

The ovary is inferior but always bilocular with two pendulous anatropous ovules, one in each cell Schnarf[6] reports in *Alangium Handelli* a bilocular ovary with one ovule in each loculus, although only one of the two develops to maturity. But in *Alangium lamarckii*, Gopinath[1] and Hooker[3] state that the ovary is unilocular.

A single massive integument (and not 2 integuments as recorded by Hutchinson,[4] originates from the base of the nucellus and grows enormously forming a long and narrow micropyle. The inner epidermis of the integument develops into an integumentary jacket layer, previously known as the epithelial layer, as has been observed in *A. Handelli*,[6] and *A. lamarckii*.[1] In some members of the allied family Cornaceae *e.g. Benthamia*[3] and *Cornus*[5], the occurrence of this type of tissue has been reported and this is found to be a characteristic feature in many members under the order Umbelliflorae. In this

material the nucellar cells get disorganized completely on all sides of the embryo-sac, though Gopinath[1] observes it to be different. The well-developed conducting strand consisting of elongated cells occurs also as is found in *A. Handelii*[6] and *A. lamerckii*[1].

The endosperm is cellular like Cornaceae from the very beginning (Fig. 2) and not nuclear at first and then cellular as in *A. lamarckii*[1]. The endosperm cells, however, store large quantities of reserved food matters like *A. lamarckii*[1].

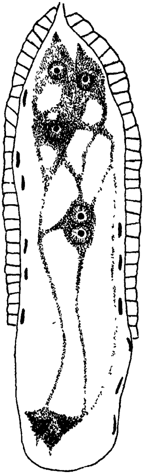


FIG 1. Eight nucleate embryo-sac with integumentary jacket layer and degenerated cells of the nucellus. (X750)

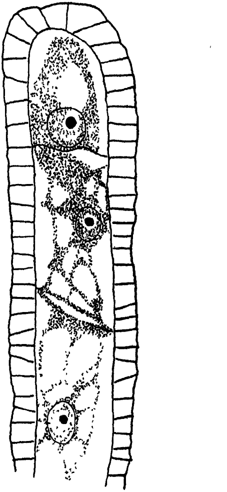


FIG 2 Endosperm nucleus after division forms two cells with cell walls Egg is seen at the upper end. (X750).

There is a single hypodermal archesporial cell, which divides into a primary parietal cell and a megaspore mother cell. The latter undergoes the usual reduction division and forms a linear tetrad of megaspores, of which the chalazal one alone functions and the upper three degenerate. The development of the embryo-sac is of the monosporic eight-nucleate type (Fig 1) but the egg is not large and the synergids are pointed at their tapering ends and vacuolated at their bases. The polar nuclei meet early and get fused The antipodals are uninucleate but they always degenerate very early.

The entry of the pollen tube is of the usual porogamous type.

The full details will form the subject matter of another paper

J. N. MITRA
R. M. DATTA

Intermediate College, Dacca and
Jute Agricultural Research Laboratories,
Tejgaon, Dacca
1-1-1947.

[1] Gopinath, D M., *Proc. Ind. Acad. Sci.*, **22**, 225-231, 1945.
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[6] Schnarf, K., *Sitz Akad. Wien. Math Nat. K. I.*, **131**, *Abt. I.*, 199-208, 1922.

STUDIES IN STEROLS AND BILE ACIDS

FOLLOWING investigations have been made with a view to synthesizing Wieland's tricarboxylic acid $C_{13}H_{20}O_6$[1]

Ethyl acetosuccinate and ethyl cyanoacetate were condensed according to Cope's modification of Knoevenagel's method[2] in presence of ammonium acetate and acetic acid in dry benzene solution. The addition of hydrocyanic acid to the ethyl 1-cyano-2-methyl-Δ^1-butene-1, 3, 4-tricarboxylate (b.p 170-180°/9 mm, m.p. 125-126°; Found, C—57·5%, H—6 7%; $C_{15}H_{21}O_6N$ requires C—57 9%, H—6 75%), thus obtained, was carried out according to the method of Hope and Sheldon[3] and the crude ethyl 1, 2-dicyano-2-methylbutane-1, 3, 4-tricarboxylate was hydrolysed by prolonged refluxing with concentrated hydrochloric acid The gummy acid obtained was esterified in the usual way and ethyl 2-methylbutane-1, 2, 3, 4-tetracarboxylate (b.p 180-190°/5 mm, Found, C—56 4%, H—7 75%, $C_{17}H_{28}O_8$ requires C—56 66%, H—7·77%) was obtained in rather poor yield Dieckmann's condensation of the above tetraester in presence of pulverised sodium yielded ethyl 3-methylcyclopentanone-3, 4, 5-tricarboxylate (b p 170-172°/4 5 mm, Found, C—57 6%, H—7 0%; $C_{15}H_{22}O_7$ requires 57 3%, H—7 0%), which was hydrolysed by refluxing with an excess of 20% sulphuric acid to give 3-methyl*cyclo*pentanone-3, 4-dicarboxylic acid (m.p 169°, Found, C—50 9%, H—5 2%; $C_8H_{10}O_5$ requires C—51 6%, H—5 4%). This keto-dicarboxylic acid was reduced by Clemmensen's method, when 2-methylcyclopentane-1, 2-dicarboxylic acid was obtained (Found, C—56·05%, H—7 0%; $C_8H_{12}O_4$ requires C—55 8%, H—6 9%) The above dicarboxylic acid, after crystallisation from dilute hydrochloric acid, was found to melt at 141°. This acid had previously been prepared by Dutta[4] by a different route and was shown by him to have the *trans*-configuration. The mixed melting point with an authentic sample supplied by Dr Dutta was found to be identical.

Further, the potassio-salt of well dried crude ethyl 1, 2-dicyano-2-methylbutane-1, 3, 4-tricarboxylate was condensed with methylheptyl iodide and on working up, the crude condensation product was hydrolysed by refluxing with hydrochloric acid. Acidic fraction isolated in the usual way from the above operation was esterified, when ethyl 1-iso-octyl-2-methylbutane-1, 2, 3, 4-tetracarboxylate (collected bet. 200-220°/4 mm.; Found, C—63·1%, H—8·5%, $C_{25}H_{44}O_8$ requires C—63·5%, H—9·3%) was obtained in a very poor yield. The isooctyl-methyl-butane-tetracarboxylic ester was then subjected to Dieckmann's condensation and the crude β-ketonic ester (shows positive ferric reaction), obtained therefrom, was hydrolysed by refluxing with 20% sulphuric acid. The product thus obtained resisted all attempts at crystallisation and was esterified by alcohol-sulphuric acid method to yield ethyl 2-isooctyl-3-methyl*cyclo*pentanone-3, 4-dicarboxylate (collected bet 180-190°/3·5 mm, Found, C—68·6%, H—9 1%; $C_{20}H_{34}O_5$ requires C—67 8%, H—9 6%)

Thanks are due to Prof. P. C Mitter for the interest he has taken during the progress of this work. Thanks are also due to Dr P. C Dutt, D Sc, and Mr N Ghose, M.Sc for the supply of the authentic specimen of *trans*-2-mythyl*cyclo*pentane-1, 2-dicarboxylic acid and for carrying out micro-analyses of some of the compounds respectively

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1 Wieland and Dane, *Z. Physiol Chem.*, *216*, 91, 1933
2 Cope *et al.*, *J. Am. Chem. Soc*, *63*, 3542, 1941
3 Hope and Sheldon, *J C S*, 2223, 1922
4 Dutta, *J Ind Chem. Soc*, *17*, 611, 1940

FERRISIA VIRGATA CKLL. (COCCIDAE), A NEW PEST OF JUTE (*CORCHORUS OLITORIUS*) IN BENGAL

Ferrisia virgata Ckll. is a fairly common mealy bug, and has been recorded in India on a number of host plants, such as, Cotton (*Gossypium* spp.), *Bhindi* (*Hibiscus esculentus*), *Cissus discolor*, *Sesbania grandiflora*, Custard apple (*Anona squamosa*), Violet (*Viola odorata*), Tomato (*Lycopersicum esculentus*), *Acalypha indica*, Crotons, *Lantana* Sp, Pepper vines, *Dolichos lablab*, assuming the status of a pest in some cases, but there is no record of its occurrence on jute It has, however, been observed for the first time in the Dacca Farm in 1944, causing considerable damage to jute (*C. olitorius*), particularly to those plants which were under selfing covers for experimental purpose. In the following year, it was noticed before the plants had started flowering. The damage is caused by the nymphs which usually remain congregated around the mother and suck up the sap of the stems, petioles and pods, and occasionally of the leaves. The affected stems become stiff and growth of the plants is considerably checked. The injury caused to stems results in the formation of 'wound cork' due to which the fibre bundles resist separation at the time of retting, on account of the cork layers

sticking to it Actually, more damage is caused to the seed plants, as a result of which they do not put

FIG. 1 Adult *Ferrisia virgata* Ckll

forth the usual number of pods The infested pods also do not grow to the normal size, become deformed

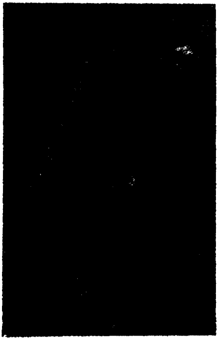

FIG 2. *Corchorus olitorius*—heavily infested top shoot.

and remain abortive It is interesting to note that the pods inside the selfing cover in the experimental plots were found seriously infested, as the pest could multiply therein unhampered by parasites and predators *Capsularis* varieties are very rarely attacked

The female (Fig. 1) has a pair of white, stout filaments at the anal lobes The whole body is covered with white powdery meal and cottony hairs When a large number of them remain closely congregated, the tops and the pods appear white from a distance (Fig 2).

The males are scarce, consequently, parthenogenetic reproduction is a common phenomenon The eggs are laid in advanced stage of embryonic development and hatch in about twenty minutes after deposition during the months of October and November The reproductive capacity of the females is very high and as many as one thousand eggs can be laid by a female during a course of two or three weeks, after which it dies

Further studies on the life-history and control of the pest are in progress

G M DAS

Jute Agricultural Research Laboratories,
Tejgaon, Dacca, 10-1-1947

"CELLOPHANE"

IN a note entitled "An Improved Process for the Manufacture of Cellulose-Acetate for the Preparation of Cellophane Paper and Raw Photographic and Cinematographic Films" by Mr P K. Choudhury, published in the June 1946 issue of "SCIENCE AND CULTURE", the word "cellophane" was used inadvertently in such a manner as might tend to create the impression that cellophane is the name of a material The word "Cellophane" is, of course, the trade mark of British Cellophane Limited, and denotes, exclusively and distinctively, the brand of cellulose sheets and films supplied by that Company. "Cellophane" should not be confused with other makes of transparent cellulose sheets and films.

London, 22-1-1947. Director, British Cellophane Ltd.

INDIAN SCIENCE CONGRESS

THE Thirty-fourth Annual Meeting of the Indian Science Congress Association was held at Delhi from 3rd to 8th January last The meeting was held for the first time under the aegis of the Interim National Government. Pandit Jawaharlal Nehru, Vice-President, Interim Government presided.

It may be recalled that Pandit Nehru was elected General President of the congress for the thirtieth sessions but owing to his incarceration he was unable to preside and Mr D N. Wadia, General President for the twenty ninth session, continued in office

The Indian Science Congress does not restrict the election of General President to men of science only but elects also such illustrious public men as have rendered conspicuous service in influencing the growth of scientific organizations in the country Pandit Nehru has studied the needs of the country and had given much time and anxious thought to the future reconstruction of the country, as president of the National Planning Committee since 1938 In fact, the Indian Science Congress was inaugurated in 1914, under the distinguished presidentship of the late Sir Ashutosh Mookerjee, an erudite jurist and educationist. Later, in 1941, Sir Ardeshir Dalal held this high office in recognition of his conspicuous services to the industrial development of the country

The session was further marked by the presence of a delegation of British, American, Canadian, French, Chinese and Soviet scientists,* who actively participated in the proceedings of the session and later toured the different University centres in India

The inaugural session was held in the presence of a very large gathering of delegates, members and visitors in the open lawn of the Delhi University The sky was overcast and there were occasional drizzles

A number of messages from India and abroad were read at the meeting, including those from Mr C Rajagopalachari, Member for Education, Sir Henry Dale, President, Royal Society, Field-Marshall Smuts, Mr Winston Churchill, and Academy of Sciences, U.S.S R

Extending a cordial welcome to the delegates and the visitors at Delhi, Sir Maurice Gwyer, Vice-Chancellor, Delhi University, and Chairman of the Local Reception Committee, said, "I hope this meeting of the Science Congress will mark the beginning of a reorientation of the attitude of Indian Universities towards science There has been, I think, too great a preoccupation in the past with lectures, to the prejudice sometimes of true learning and research. None denies the importance of learning and research , but there is still room for a more complete recognition of the fact that the greatest and most vital function of a university is to increase the bounds of human knowledge, to be a centre of culture in the broadest sense, to be the guardian of fundamental values and to set the standards for its generation To achieve it will be made more easy, by the new attitude of the authorities here towards the universities and by the munificent grants which by a welcome change in policy they are now beginning to make If the assistance thus generously given is not allowed to prejudice the autonomy of the uni-

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* The following foreign delegates attended the Congress .

(1) Dr W. F. Hanna, Senior Plant Pathololgist, Dominion Rust Research Laboratory, Winnipeg, Manitoba and (2) Dr T. S. Tanton, Senior Geologist, Geological Survey of Canada, *represented the National Research Council of Canada*, (3) Dr R. B. Thomson, Emeritus Professor of Botany, Toronto University, *represented Royal Society of Canada;* (4) Dr E N. Harvey, Fairfield Osborn Professor of Biology, (5) Dr O Riddle, Member of the Research staff in experimental evolution, Carnegie Institute, and (6) Dr H Shapley, Director of the Harvard Observatory, *represented National Academy of Sciences, U S A.;* (7) Dr A F Blakeslee, Neilson Research Professor of Botany, Smith College and Director, Genetic Experiment Station, Massachussetts and (8) Dr W. E. Deming, Sampling Adviser, Bureau of Budget, Washington, *represented the American Association for the Advancement of Science;* (9) Sir Charles Darwin, Director, National Physical Laboratory, (10) Sir Arthur Fleming, Director, Research and Education Dept., Metropolitan Vickers Electrical Co. and (11) Prof. H. Munro Fox, Prof. of Zoology, Bedford College, London University, *represented the British Association for the Advancement of Science;* (12) Prof. P. M. S. Blackett, Langworth Professor of Physics, Mancheater Univerisity, (13) Dr W Brown, Professor of Plant Pathology, and Head of the Botany Department, Imperial College of Science, London, (14) Prof. L J Mordell, Sadleirian Professor of Pure Mathematics, Cambridge University, (15) Sir Harold Spencer-Jones, Astronomer, Royal Greenwich Observatory, (16) Dr P B. White, National Institute of Medical Research, London and (17) Sir D'Arcy Thomson, Professor of Natural History, University of St Andrews, *represented the Royal Society of London.* The British delegation also included (18) Prof. L. Dudley Stamp, Chief Adviser on Rural Land Utilization to the Ministry of Agriculture. (19) Prof. Jacques Hadamard, Professor of Mathematics, College de France, Paris, *represented the French Academy* and (20) Prof. S. S. Chern, Professor of the Mathematics, *represented China.*

The delegation of Russian Scientists, led by (21) Prof. V. P Volgin, Vice-President, Academy of Sciences, U S.S.R included (22) Prof. E. N Pavlovsky, President, Tajik Branch of the Academy of Sciences, U.S.S.R. and (23) Prof. M. Umarov, Professor of Physics at the Middle-Asian University, arrived late and were entertained at a special meeting of the Congress held on the 7th January.

versities—for that is a precious possession which they cannot yield to without being false to everything for which they stand—a future lies before us incomparably greater than anything which the universities have known in the past."

Besides the usual sectional meetings and discussions, a large number of popular lectures were also organized and delivered by distinguished Indian and foreign scientists.

Sir Shanti Swarup Bhatnagar and Prof D. S. Kothari as local secretaries rendered conspicuous services for the success of the Congress

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Science in the Service of the Nation

Pandit Jawaharlal Nehru's General Presidential Address at the Indian Science Congress, Delhi

"I SHOULD like to assure this Science Congress and our friends who have come from abroad that we want to co-operate with science abroad in every way to advance the cause of peace in the world, peace and progress of humanity. But while giving that undertaking and pledge, I want to make it perfectly clear that we will not co-operate in the ways of war," said the Hon'ble Pandit Jawaharlal Nehru, Vice-President of the Interim Government, in his presidential address to the 34th session of the Indian Science Congress which met on January 3, 1947, at the University grounds, Delhi.

Pandit Nehru expressed the hope that now, when India was on the verge of independence and science in India too was coming of age, it would try to solve the problems of the New India by rapid, planned development on all sectors and try to make her more and more scientifically-minded

Surely, said Pandit Nehru, science was not merely an individual's search for Truth It was something infinitely more than that if it worked for the community. "For a hungry man or a hungry woman, Truth has little meaning He wants food. For a hungry man, God has no meaning. He wants food. And India is a hungry, starving country and to talk of Truth and God and even of many of the fine things of life to the millions who are starving is a mockery. We have to find food for them, clothing, housing, education, health and so on—all the absolute necessaries of life that every man should possess. When we have done that we can philosophise and think of God. So, science must think in terms of the 400 million persons in Iddia. Obviously, you can only think in those terms and work along those lines on the wider scale of co-ordinated planning."

Pandit Nehru hoped that the Science Congress would devote itself to this talk and not wait merely for Government to take action "Governments may be good and may be bad" said Pandit Nehru, "but Governments normally are very slow and the only thing that moves them is some immediate public outcry which affects their future indirectly. Therefore, I should discourage among the scientist a reliance always on what Government may or may not do

Scientific Development

"Naturally, they have a right to expect things from Government, and, speaking just as one member of the present Government of India—speaking, may be, partly for my colleagues but largely for myself—I may say that we are intensely interested in scientific development in India and we shall do everything in our power to encourage scientific research We should like to tap all the latent scientific talent in the country and to give it opportunities for growth and service to the community.

"What the future will bring I do not know, I can neither foretell the future, nor have I any authority to bind my country down to what it may or may not do in future, but in these days, so soon after the last war, when people again think of wars and when scientists are yoked into work in preparation for future wars, I think it is desirable and necessary that men and women of science should also think about the way they are often misused and exploited for base ends and should make it clear that they do not want to be so exploited

"Anyway, I do hope that India in future will not allow herself to be dragged into wars which are

likely to be far more terrible than any that we have experienced thus far

"I say that, and yet I know how difficult it is for a line to be drawn between scientific work for peace and for war. This great force—atomic energy —that has suddenly come through scientific research may be used for war or may be used for peace. We cannot neglect it because it might be used for war, obviously in India we want to develop it, and we will develop it to the fullest Fortunately we have eminent scientists here who can do so We shall develop it, I hope, in co-operation with the rest of the world and for peaceful purposes

"It is a tragedy that, when these enormous forces are available in the world for beneficient purposes and for raising human standards to undreamt of heights, people should still think of war and conflict and should still maintain economic and social structures which promote monopoly and create differences in standards of wealth between various groups and peoples It is a tragedy, whatever other people might say about it, and no man of science should accept it as a right ordering of events So in India to-day, while we are busy with our own political and economic problems, we have inevitably begun to think more and more of the vaster problems that face us and in the decision of which science must inevitably play a big part.

"I invite all of you who are present here, young men and old in the field of science in India, to think in these larger terms of India's future and become crusaders for a rapid bettering of the 400 millions in India, and crusaders of peace in India and the world and international co-operation for peace and progress."

Bombing of Hiroshima

Describing the atom-bombing of Hiroshima as "horrible beyond words," Pandit Nehru said "Science has its destructive side and constructive, creative side. Both have gone on side by side and both still go on. No one knows which will ultimately triumph. Hiroshima became a symbol of this conflict and, in spite of all the decisions of the Atomic Energy Commission of the UNO—and we welcome those decisions, of course, in so far as they go—the doubt remains in one's mind as to where we are speeding.

"On the other hand, apart from the atomic bomb aspect of it, we are obviously on the threshold of a new age in the sense of enormous power resources being put at the disposal of humanity and the community. Will this new age change—and I think it will change—enormously the whole structure of society? My mind goes back to the time when gunpowder burst upon the world Gunpowder at any rate pushed the Middle Ages away completely, and fairly rapidly, in course of time, brought or helped to bring about a new political and economic structure

"Of course, there were many forces at work Nevertheless, gunpowder did produce that powerful effect on society and ultimately out of that feudal order a new capitalist order gradually developed Now I wonder whether this so-called atomic bomb is not also the herald of a new age, of a new structure of society which has to be established in order to fit in with present conditions I myself am convinced that there is going to be no very great progress either in science or in other ways unless certain fundamental changes take place in the social structure."

Communal Disturbances

Referring to the communal disturbances, Pandit Nehru said · "Many of us are naturally tremendously worried with some events that are happening in India Many of our friends from abroad must also have their minds filled with the picture of conflict in India because that conflict, bad as it is in India, is magnified a hundredfold when it crosses the seas and people seem to think that the sole or main occupation of the people in India today is to cut each other's throat

"While conditions are in some respects not at all good, still, when we think of the brighter picture of India, whose people, after having been largely static for many years, are in motion today, then those conflicts become rather petty in their perspective. When a whole people are on the move, they go astray here and there, but the main thing is the vitality they possess and, even if they go astray, they will come back to the right path

"That is the real thing, the encouraging thing, that makes one certain that India has a tremendous future in store for her and that, as soon as we get over our present troubles, there will be a flowering of science and other activities in India which will probably astonish the world.

"The first objective, it seems to me, from any point of view and more especially from the point of view of science, is to help in the building of a free and self-reliant India. India today has made its mark in the world of science, more especially in theoretical physics and some other departments also. We have done well when we have hardly tapped the talent in India. We have only scratched the barest surface of the Indian people, and yet we have done tolerably well and now, when I think of what we can do and will do no doubt, when we open the doors

of opportunity to a large number of people in India, then the kind of picture I see rather overwhelms me. If we could tap, say, even five per cent of the latent talent in India for scientific purposes, we would have a host of scientists in India".

Pandit Nehru welcomed the foreign delegates present and concluded: "I hope this Science Congress, meeting at a time which in India's history is a very significant time, will prove also very significant in the development of science in India."

Statistics

Design of Experiments

R. C. Bose

STATISTICS is a young science and its potentialities for the advancement of human knowledge and welfare are as yet largely unrealized and unexplored But in view of the distinctive position that it occupies among the sciences, it is destined to play an ever increasing part in the onward march of humanity. For on the one hand recent developments of statistical concepts and theory provide a basic tool and methodology for reserach in the fundamental sciences, while on the other hand its applications extend to the whole range of applied and social sciences.

After mentioning the brilliant triumphs won by science in the 19th and the first half of the 20th century by the method of planned experimentation, Mr Bose pointed out that the initial triumphs of this method were won in those fields only, where the experimental material was homogeneous He traced how the problems of statistics arose from the need for a scientific approach to the study of heterogeneous material, and gave a brief review of the main currents along which statistical thought had advanced during the last half a century He discussed in particular the problems of 'distribution', 'estimation' and 'testing of hypotheses', which are inherent in statistics, and which inevitably occur in some form or other in the reduction or analysis of any mass of statistical data. But every experimenter must face the prior problem of 'design', which in the most general sense can be regarded as the problem of determining the 'optimum' allocation of the experimenter's resources in the collection of observations.

Confining himself to the problem of 'Design of Experiments' in the sense of Fisher, Mr Bose brought out its connection with the theory of 'linear estimation and tests of linear hypotheses'. He then proceeded to give a sketch of this theorv from a generalized stand point developed by him

Mr Bose showed how the combinatorial problems of the design of experiments, arise from the necessity of reducing the block size so as to ensure adequate 'local control', and at the same time so arranging the experiment, that the relevant treatment contrasts can be estimated without unduly complicated analysis He then reviewed at some length the work done by himself and other Indian statisticians and mathematicians on various important combinatorial problems of design, *viz*, the problems of construction of (*i*) complete sets of orthogonal Latin squares, (*ii*) 'balanced' and 'partially balanced' incomplete block designs and (*iii*) factorial designs with specified characteristics He brought out in particular the utility of the methods of Modern Algebra, especially the theory of Galois Fields and Finite Geometries, in connection with these problems He referred to the mathematical theory of factorial designs developed by him and Kishen, and noted how it could be used to generalize recent results of Fisher, regarding the maximum number of factors which can be accommodated in a symmetrical factorial experiment (with a given number of levels), without confounding interactions of order lower than a given one.

Mr Bose concluded by stressing the fact that fundamental progress in the application of statistical methodology to any particular field of enquiry is not possible without the intimate co-operation of the theoretician and the experimenter, and said that the greater contribution which statistics could make to general progress and development in India, would be limited only by the extent to which our organisers of science and industry, succeed in establishing a fruitful co-operation between the experimenter and the applied worker on the one hand, and the theoretical and mathematical statistician on the other.

Mathematics

Possible Application of the Functional Calculus

D. D. Kosambi

IN the life of every country with any technical development, graphs, generally recorded by automatic instruments, play an increasingly prominent role The commonest are perhaps those connected with meteorology namely the diurnal or weekly automatic records of barometric pressure, temperature, humidity, and wind velocity In anthropometry the entire profine can be recorded by means of a single picture whereas older anthropologists preferred to describe the human cranium by means of various special 'characters'. In medicine we have a considerable accumulation of pulse wave records and metabolic rate charts to which are added such decidedly more complicated pictures as the electrocardiogram and the Berger rhythm The electrical engineer has long specialized in polar co-ordinate records with relation to his instruments Analytical Chemistry adds a new and tremendously important set of records from the polarograph

The general method of dealing with these is to take a series of numerical measurements from them, treat each measurement as a separate number and apply classical arithmetic or statistical methods What is wanted is a theory that will treat the entire continuously recorded graph as one single unit To this end we need both theoretical and practical tools Only by means of a complete theory and proper calculating machines can we work out averages, variances, co-relations and say whether or not sets of records from two or more different in the information that they give. Theory involves considerations of space with infinitely many dimensions and in such space the measurement of 'volume' has always presented special difficulty These theoretical difficulties, however, have recently been overcome to such an extent that it now remains to consider chiefly the practical *i e*, mechanical side of the work To this end we need calculating machines of a special type which do for continuous graphs what ordinary calculating machines do for numbers. That is, these machines should be able to add or subtract, to multiply and in special cases to divide any number of graphs in one continuous operation, and to write down the result as a graph to a justifiable scale This should be performed directly, without the intermediate use of numerical measurements and arithmetic computation as with punched-card machines which, no matter how fast, are not wholly suitable The present dissertation only shows what could be done by means of such machines without going into the technical details of their manufacture which would actually be problem in engineering Let it be said that such machines are entirely practicable and some have actually reached an advanced stage of construction

Physics

Disorder in Atomic Architecture

K. Banerji

THE physical properties of crystals and the perfect geometry of their faces led the mathematical crystallographers of the nineteenth century to postulate regular atomic architecture inside them This theory had found remarkable verification at the hands of Laue and Bragg from the diffraction of X-rays. Since then X-rays have been used to determine the internal atomic arrangements of solids As X-ray studies were extended ordered arrangements were found to prevail over a much wider range of substances than hitherto suspected Not only materials which were known to be crystals from their external forms but many other solids were found to be crystalline in nature. Even fibres such as cellulose and silk have a regularity of internal molecular arrangement. It was, however, soon found that inspite of this universality of the atomic arrangements inside solids, perfect arrangement was a thing that could be

approached but never attained Even if we can imagine that the atoms inside a crystal have perfect geometrical arrangement at the absolute zero of temperature at other temperatures due to heat the atoms would oscillate about their equilibrium positions, and perfect geometrical arrangement at any instant of time will have no meaning. Over and above the want of perfect arrangement due to thermal motion it has been found that a single crystal as we call it consists of a very large number of submicroscopic mosaic blocks arranged nearly but not exactly parallel to each other whose average sizes vary from substance to substance. Also there are accidental defects and distortions whose causes are still not satisfactorily known. Then there is possibility of lattice oscillations excited by any radiation that might be incident on the crystals. It is a curious fact that most of the desirable and undesirable properties of materials depend upon these defects of the atomic architecture and hence great interest has been aroused in the study of these atomic derangements in crystals during recent years.

X-ray diffraction has been found to be a very convenient method of studying these imperfections. The method consists in taking overexposed Laue photographs of the crystals at different orientations. If the crystal had perfect atomic arrangements the photograph would consist of a pattern of sharp spots in the positions obeying Laue's equations. Any spot or blackening outside these spots is the effect of imperfection of atomic arrangement By a geometrical representation of the results of the X-ray study, it is possible to distinguish between the different types of derangements mentioned above. Thus thermal oscillations have been found to be a universal cause of derangement and static imperfections of atomic arrangements have also been found in a number of cases. Excitation of oscillations due to incident radiation as a cause of disorder has been found in benzil, diamond and phloroglucine dihydrate crystals.

Botany

The Morphology of the Gynoecium

A. C. JOSHI

A STRONG plea is made for the retention of classical floral morphology, according to which the gynoecium is composed of one or more, free or variously united carpels, and each carpel is morphologically equivalent to a leaf folded upwards along its midrib and bearing ovules along its incurved margins. The anatomical studies support this hypothesis. It is also supported by some recent work on the genetics of gram The Caytonialean carpel of Hamshaw Thomas, Carpel Polymorphism of Saunders, and the theory of Acarpy put forward by McLean Thompson do not rest on any strong evidence. A critical review of the conclusions of Prof. Gregoire also shows that exceptions exist to every one of the differences pointed out by him in the histogenesis of the foliar and floral buds.

Anatomical investigations of epigynous and perigynous flowers demonstrate that the inferior ovary or the calyx-tube is of axial nature in very few cases, *e g., Rosa, Calycanthus*, Santalaceae and perhaps Juglandaceae. In most flowering plants perigyny and epigymy are the result of the fusion of the basal portions of the calyx, corolla, stamens and the ovary, and the inferior ovary is appendicular

In the syncarpous gynoecium, the multilocular ovary with axile placentation is the primitive condition. The unilocular ovary with parietal placentation is a later development. It is a case of retention in the adult stage of a character observed in the multi-locular ovary in an early stage of development. The free central placenta is of carpellary nature in all cases, while the solitary ovule is the result of reduction from a multiovulate condition.

The origin of the different forms of ovule is still obscure. Probably mechanical pressure exerted during development along with mutations in the same direction have together determined the evolution of the different types. The anatropous ovule is now the most common, because it is the best adapted to the porogamous mode of fertilization.

Anthropology and Archaeology

Some Problems of Indian Anthropology

DR (MRS) IRAWATI KARVE

IN her presidential address, Dr Karve has described the Physical Regions of India and the routes of migration of ancient times emphasizing the characteristic role played by the Vindhyan Range as a barrier between the north and the south. The importance of the intensive study of the cultural regions of India, their languages, family organizations, kinship terminologies and folklore, all of which follow a definite spatial pattern is stressed. It is indicated that this would make it possible to give a chronological interpretation to the present spatial pattern.

Within each such region are the consanguine groups called castes and sub-castes The physical and cultural study of these groups will also help to solve the above problem.

Finally excavations on historical and prehistoric sites will help to determine when and how the present humanity with its different cultures and different features came to settle India

Medical and Veterinary Sciences

The Study of Skin Diseases in India

G. PANJA

STUDY of dermatology or skin diseases is not receiving so much attention in India, as it ought to have done. The disease is important, very common in India, brings untold sufferings to many and some of the diseases are extremely obstinate. The skin is developed from the same embryonic structure, *viz* ectoderm as the central nervous system, the brain, etc. and it serves many important and vital functions of the body.

Dermatology is not so neglected in Europe and America as in India. It is a compulsory subject in those countries for a qualifying examination and the subject can be taken as a speciality in post graduate study. There are ample facilities for dermatological graduate study, large numbers of dermatological societies are in existence, clinics are well furnished with modern equipments, about 30 to 40 thousand cases are treated in a year, intensive research is carried on and all research activities are recorded in an Year Book of dermatology.

The proportion of skin cases in India to the total number of all diseases varies from 2 to 10 per cent of the total. Military dermatology in India has shown that "the disability due to skin diseases in the armed forces varies from 20 to 70 per cent of all disability due to disease and in some theatres of war 75 per cent of all disability is due to skin disease" Hence the possibility of establishing adequate and complete institutes of dermatology in India has been stressed and it is hoped that a recommendation for the establishment of a Central Indian School of Dermatology in India in the near future will be forthcoming. Such a school should carry on an intensive research work on the subject with the help of best brains of India and attract foreign students to study the subject

LEUCODERMA

The disease is fairly common in India but its cause is still obscure. It is neither hereditary nor contagious and has nothing to do with leprosy, syphilis or gonorrhoea. It is such a disfiguring disease that further research work is needed in order to find out the exact aetiology and an ideal cure.

Researches in the School of Tropical Medicine have shown that the disease is caused in most cases by a gastrointestinal toxin which affects the sympathetic nervous mechanism controlling the pigment metabolism in the skin There are no germs, microscopic or ultra-microscopic demonstrable in the disease

An effective drug has been found, which acts on the sympathetic and by so doing stimulates the melanoblasts to form pigment This is incorporated in the form of an oil, called *psoralea* oil for external application or in the form of an intradermal injection into the patches Besides, internal treatment is given to eliminate septic foci in the body and to build up the vitamin B_2 complex deficiency

Allergic dermatitis including neurodermatitis and eczema is a very common, distressing and obstinate skin complaint A further intensive research in such a common condition is desirable. The problem of desensitization demands our adequate and careful study. It is a great pity that little scientific attention is paid to allergy in this country and students after qualifying have very little knowledge on such an important subject

Tropical phagedenic ulcer (Naga sore) is proved to be caused by fusiform bacillus and is treated by penicillin with dramatic success Several skin conditions are amenable to treatment by new drugs such as benzyl benzoate, sulphonamides, penicillin and streptomycin

CONTROL OF LEPROSY

This is a very important problem in India. There are about 10 lacs of cases of leprosy here and at least two and a half lacs are infective and therefore potentially dangerous to the population at large In some provinces of Bengal, the incidence is as high as about 5 per cent. The infection is contracted in most cases in childhood or early adult life by contact with cases or by room contact usually through some skin disease or injury. Hence it is of great importance to take strict sanitary care of a child's skin and its skin disease such as, impetigo, eczema, boils, pruritis, cuts, etc. The control of leprosy should be considered under the following heads: (1) education, not only of the public but also of medical men, (2) detection of cases, at least of those which are infective, (3) compulsory notification of infectious cases, (4) isolation of infectious cases, either voluntary which is more desirable or compulsory in special circumstances, (5) intensive research with a view to find out a good or specific cure for the disease.

The disease is spreading and one of the reasons of such a spread is that early diagnosis is not made and cases are not detected General practitioners who can take an active and essential part in the control are mostly ignorant of the disease and are therefore unable to spot the disease in the early stage We should build one or more asylums in each province and there should be a *Leprosy Institute of India* to carry on research work on the disease. There are millionaires and many benevolent-minded persons in India, some of whom have already established asylums here The British Mission to lepers and the British Empire Leprosy Relief Association and others have done and are doing splendid work in this direction.

STANDARD DIAGNOSTIC LABORATORIES

Here in India, standard diagnostic laboratories are few and far between Medical practitioners especially in rural areas are often handicapped for want of laboratory facilities. The capital of each province should have a Government Standard Laboratory and in each district head quarter there should be a miniature one where all standard reagents will be prepared and standard laboratory examinations conducted and whencefrom all reagents will be issued at reasonable costs to private practitioners, laboratories and district boards, etc If such a system be introduced, a patient even in a remote village is likely to enjoy the benefit of an early and accurate diagnosis. The programme of such an organization should be included in our national planning.

Physiology

Recent Trends in Electrocardiography

S. A. RAHMAN

THE heart has ever been the subject of absorbing interest to biologists and to laymen alike. Till the 17th century, the heart was regarded by philosophers as the source of the body heat and the seat of the vital spirit. In the seventeenth century the great William Harvey is said to have been so bewildered with the complexity of heart movements that he cried out in desperation that the movements of the heart could be understood by God alone

In 1786, Galvani, an Italian Physiologist, made the epoch-making discovery that electric currents were produced in muscle when it contracted Not much information, however, was obtained about the electric currents produced by the heart till the introduction of the electrocardiograph by Einthoven at the beginning of the present century. The electrocardiographic method of investigation has been of great value not only for understanding the normal mechanism of heart action but also in investigation of diseased conditions and in evaluation of the efficacy of treatment Today we are in a position to judge not only whether the heart of a subject is damaged or not but also we can define to an amazing degree of accuracy the site of the damage Such a judgment was not possible a few years ago Recent trends in electrocardiography have been towards the elaboration of the technique and greater accuracy in judgment. Thus we see that the technique developed in physiological laboratories has proved of immense value in clinical investigations.

Physiology would make a more rapid advance on the basis of team work While some physiologists devote themselves entirely to laboratory work, others make use of the clinical material where nature makes experiments on human beings which are hardly possible in the laboratory Or, what is perhaps the same thing, we want clinicians who are more physiological minded A greater application of physiological technique in clinics will give us a better insight into the physiology of diseased conditions and will be of help both to physiology and to clinical science.

Psychology and Educational Science

Psychology and the Rehabilitation of Human Society

P. S. NAIDU

THE human situation both at home and abroad is a source of great perplexity to those who wish to plan for the future welfare of mankind. Man seems intent on bending all his energy to a career of destruction and self-immolation The pessimist is perhaps right when he denounces sarcastically all theories of progress as 'ridiculous escapisms, fashioned by timid, bloodless and unimaginative spiritual bankrupts.' But we are constrained to ask why, in spite of all his efforts through the ages to uplift himself, is man still at the primitive level, a slave to animal instinct and passions? To my mind it seems that the cause is man's failure to plan on right lines. So long, man has been thinking and planning for improvement in terms of the outer environment, neglecting the vital factor in the whole situation, namely, the PSYCHOLOGICAL FORCES in his own inner SELF. Therefore, it appears that there is hope of real progress only if the present plans which aim at the ordering of the outer environment be supplemented by a scheme for adjusting these plans to the nature and needs of man's inner psychological self *Psychological planning is indicated by the contemporary human situation as the most urgent need of the hour.*

A psychological diagnosis of the universal malady that man is suffering from reveals three deep-seated causes for the disease. The first is maladjustment

between man's innate abilities, talents and temperament on the one hand and on the other the environment in which he has to live and work, the second is a whole crowd of undetected and unruly complexes lurking in the unconscious needing catharsis, and sublimation and the third is the total neglect and often senseless antagonism to spirituality The three graded objectives which, psychologically speaking planners have to aim at are *efficiency, happiness* and *self-realisation* The first is to be achieved by the aid of Applied Psychology, the second of Depth Psychology and the third of Indian Psychology For attaining efficiency which is the lowest in our hierarchy of values a nation-wide survey of cognitive and conative abilities and aptitudes of individual citizens by suitably standardized mental tests is prescribed as the means This should be followed up by an extensive job-analysis of trades, professions and occupations, and finally the right pegs should be fixed up in the right holes. Thus will be removed one potent cause of disturbance in human relations, namely, occupational maladjustment and loss and suffering consequent on it Next comes the subtle middle goal of happiness This is to be achieved by cleansing the Unconscious and by properly canalizing mental energy. Preventive and curative therapy based on analytic psychiatry should be applied to the nursery, the home, the school, the place of business, in brief to every institution organized round some intimate human relationship. The ugly complexes may thus be prevented from forming, and if formed may be drained off For attaining these two goals which will remove in a large measure ***the inner mental causes*** for war, for international ill-will and national disruptions and for individual misery and suffering three all-India organizations should be brought into existence, an All India Psychological Council composed of experts, officials, non-officials and employers of labour for directing and co-ordinating general policy ; an All-India Psychological Institute composed solely of specialists and experts for co-ordinating, guiding and stimulating psychological research in the applied field ; and an All India Psychological and Analytic-Psychiatric Service composed of field workers for carrying out the extensive psychological survey work and for manning the psychological clinics.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. APRIL, 1947 No. 10

THE INTER-ASIAN CONFERENCE AT DELHI

THE opening of the first Inter Asian Conference at Delhi on March 23 under the auspices of the first National Government of India, is a memorable event in the annals of this continent In his inaugural message to the Conference, Pandit Nehru says

"There is a struggle and turmoil in various parts of Asia, and yet behind it there is a new vitality Asia the mother of continents, is waking up from her old slumber There is something of the turbulence of youth about her today, and there is something of sparkle of youth in her eyes An age is coming to an end, and a new era is beginning for the countries of Asia"

History tells us that Asia is the birthplace of all world-religions, social and political systems, arts and crafts which have raised humanity from the state of savagery to civilized life Even barely two hundred years ago, the countries and people of Asia were free, and powerful, and had at least reached as high a standard of life, and of social and political security as the contemporary countries and people of Europe The India of Shah Jehan (1650), the Iran of Shah Abbas (1620), the Central Asia of Ulugh Beg (1440), and the China of Kwangsi (1600) were far richer and more powerful than France of Louis XIV The common people had as good a standard of living as his corresponding type in Europe, and literature and finer arts were cultivated at the courts with equal vigour and success But then set in a decline, which culminated in all the Asiatic countries, with the exception of Japan, being reduced to the position of exploited colonies by the aggressive European nations. The patterns of imperialism which were imposed on the ancient cradles of civilization were very much the same, the worst sinners being probably the Dutch and the French and the most humane and successful being the English. The great country of China, though she nominally retained her independence throughout these sad centuries, became, to use the language of Sun Yat Sen, meat for ten carving knives

Yet all Asia except Japan was in a slumber till the emergence of that country as a modern industrial nation due to her own unaided efforts, and the demonstration of her newly acquired power by the defeat of Czarist Imperialism in 1904, roused the countries of Asia to fresh hopes Ever since, the Asiatic countries have been in turmoil But what have they achieved towards the attainment of the goal freedom from the shackles of imperialism, and achievement of social and political solidarity, and above all towards the passage from an agricultural and paleotechnic mode of production to modern neotechnic methods—in other words towards a Technological Revolution, which alone can sustain newly acquired freedom, if we have acquired freedom at all? Our considered opinion is that very little progress in this direction has been made except in the Asiatic countries under Soviet Russia, or under imperialistic Japan

The two great World Wars have badly shaken the foundations of European imperialism, but it will be a mistake to think that *le diable est mort* On the other hand, under the modern system of technics, in which European nations are adept, the powers of recovery of a nation, victor or vanquished, which have been badly shaken during the War, are very quick and efficient, and European imperialism, under the protective wings of U.S A , are already staging a comeback under a new form The Asian nations would be wise if they do not, in the first flush of "newly acquired freedom", which to us is nothing more than a little relaxation of the shackles of imperialism, ignore the almost sure signs, and

rising above the petty squabbles, which are now disfiguring our public life, set to work with one mind in bringing about the technological, and economic revolution, which alone can give them the strength to resist the future onset of 'European and American aggression'.

SCIENCE IN ASIA

THOUGH Asia is universally acknowledged to be the home of the civilizations that claim to be the oldest on this globe, and though here arose the great religions tending to bind the whole of mankind, and social and political systems that have persisted even to this day, the equally reasonable claim of Asia to be regarded as the original home of sciences is generally obscured by the phenomenal development of sciences and engineering in Europe during the last four hundred years or so The European savants are strongly inclined to reserve this honour for Greece and hence for Europe But it is conveniently forgotten that Greece of ancient times included almost the whole of Asia Minor, and many of the early founders of Greek science like Thales and Anaximander, both of Miletus, actually hailed from the Asiatic parts, and were suspected to have Asiatic blood They interpreted West Asian scientific knowledge to the Greeks of the 7th century, just emerging out of barbarism The ancient Greek philosophers themselves ascribed their early knowledge of geometry and chemistry (or alchemy) to Egypt, and of mathematics and astronomy to Babylon Even later discoveries in science, once ascribed to Greek savants, have been traced to West Asian sources A glaring example is the discovery of the Precession of Equinoxes, which had been long ascribed to the ancient Greek astronomer Hipparchus, but has been recently traced to the writings of a Chaldean astronomer Kidinnu, who observed at Sippar, near Babylon, nearly a century earlier than Hipparchus Recent archaeological finds and researches conclusively indicate that many of the early discoveries and inventions in science were wrongly attributed to European Greece In fact, archaeological discoveries prove increasingly the contribution in pre-science to the East, *viz.*, Babylon, Assyria, Iran, India and China.

Much of the early records of progress in sciences in India and China are now either lost or buried in the ruins of old sites and a proper estimate of the extent of progress has not been possible even to this day. However, from what has survived the ravages of time and yielded to the explorer's spade, it appears that India and China must have also attained a very high degree of efficiency in scientific thinking and discoveries long before the Birth of Christ In mathematics and astronomy, chemistry and medicine, architecture and irrigation, agriculture and livestock breeding and some other branches of pre-sciences, this is not in doubt today

The recent excavations at Mohenjo-daro and Harappa have revealed, beyond all shades of doubt, the existence of a highly organized form of civilized life in the Indus Valley as far back as 2500 B C The patterns of the houses and of the highly efficient irrigation and drainage systems, evolved by the early people of the Indus Valley and fortunately safely protected for us in the sands of Sind, reveal clearly a considerable knowledge of town planning, and of architectural and irrigation engineering There are yet many missing links in the record of past achievements of the early Indians From 2500 B C. up to the times of Asoke (*viz* , 250 B C), we have not a single site yielding records of civilized human life in India, though the sacred literature transmitted orally contains echoes of mighty happenings within this period

The development of sciences which now usually go in the name of Europe is after all of a very recent origin— hardly four or five hundred years old No doubt, this development has been vast and phenomenal and far surpasses the aggregate achievements of man during the several thousand years of his existence previous to this period And then this period has witnessed not only great scientific and technological developments ; but, what is more important for society, a transformation from paleotechnic to neotechnic age* and fundamental revolutions in social, economic and political institutions, which have radically altered man's condition of living on earth took place in this period Before the period of Renaissance in Europe which prepared the human mind there for positive thinking and for big adventures in sciences, she was certainly not better than any part of Asia so far as sciences were concerned.

It is a great tragedy of the human drama that, from the fifteenth century onward, the once vibrant

*Paleotechnic means production of commodities by tools, in cottages, using mostly manual labour : Neotechnic denotes the production of commodities in factories, by the use of machineries and power derived from coal, oil, or water.

peoples of Asia suddenly relapsed into complete immobility, and a general decadence started in positive intellectual thinking, while Europe of Leonardo da Vinci, Galileo and Newton marched ahead along lines chalked out by the works of their great savants and assumed moral and intellectual leadership of the world. Political leadership soon followed the intellectual pre-eminence, and the seventeenth and the eighteenth century witnessed European encroachment upon the Asiatic main land. India became a dependency, a vast colonial empire was built in the rich islands of the South-East Asia, the European empire builders struggled desperately to establish themselves upon the slumbering Chinese colossus, and the economic life of the Middle and the Near East came to be more and more conditioned and dominated by Europe. Even the Islamic Asia, which preserved and fostered the knowledge of the ancient Greeks, the Indians as well as of the Chinese and for a time looked like a formidable rival of Christian Europe, ultimately proved inadequate and was swept by the surging tide of European ascendency.

It is curious that the discoveries of gunpowder, paper and printing, the decimal notation, the magnetic compass, were all made in the East, but the Eastern people made little large scale use of them.* But it is really the use of these discoveries on a large scale which led to European ascendancy. The reason is probably to be sought in the fact that there had been a complete divorce in the East between the hand and the brain, due to the institution of the caste system in India, and the institution of administration by classical scholars in China, which made it impossible for these countries to make any great mechanical discovery within the last thousand years. The impact with the forces of European imperialism in the nineteenth and the twentieth century have brought about a profound revolution in the economic, political and social organizations of Asia which may usher in what may be called, if expectations are fulfilled, an Asian Renaissance. But unless we carefully analyze the causes of decadence, all this enthusiasm may be an evanescent phenomenon. The danger is all the greater, because as a reaction to European aggression, all the institutions which led to our decadence are being extolled from the patriotic platform—primitive industrial methods, and religious fanaticism in this country,* and we are told, scholastic rule in China. This has also marked the beginning, in right earnest, of the cultivation of modern sciences in Japan, India, China, the Middle East and, last not the least, in the vast territories of the Asiatic Socialist Soviet Republics. But excepting Japan which, of all nations of the East, foresaw the necessity of overhauling her institutions, from the point of view of scientific and technological advances, and where the entire State and hence the life of the nation had been geared to science, progress of science in other parts of Asia still largely centre round a few brilliant individuals. It has yet little affected the life of the nation as a whole. Unless the Eastern countries can realize the importance of application of scientific methods to all spheres of their activity, the hopes of the expected Renaissance may be a midsummer night's dream.

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* Paper made from mulberry is said to have been known from very early times in China, but it was only in the eighth century that a knowledge of paper making was transmitted by the Chinese captives to the Arabs of Samarkand and thence to Europe.

Gunpowder appears to have been known in India, as is evident from the term 'Bengal Fire' used to describe 'fire-works'.

The magnetic compass was known to the early Chinese, but were little used by them for navigation. Block-printing from wood was also known in Chinese system of ideographic writing, and was adapted to the system of Arabic alphabet, but printing as understood now was never practised except on a small scale.

The early Portuguese and Spanish explorers depended on the magnetic compass for steering through the high seas, and on gunpowder and firearms for conquering the American aboriginals. The large scale use of books by merchants and the middle class, rendered possible by paper and printing, led to the intellectual and scientific upheavals, and to a Bourgeoise revolution in Europe. It is important to remember the part played by the Bourgeoise in European aggression, for though magnetic compass, gunpowder and firearms can explain the easy conquests of the American Indian by the Portuguese and the Spaniards, they cannot explain the success of the English, the French and the Dutch, for the Asiatic countries had as good firearms and soldiers. But there was no adventurous Bourgeoise class in Asiatic countries, due to absence of large-scale intellectual movements as in Europe. But in spite of their early conquests European nations could not have maintained their gains, if there were no Neotechnic (or Industrial) Revolution due to science.

* We offer no apology for writing in this vein. One of the great political parties of India has held out primitive industrial methods as *"panacea for all modern evils"* and we have the edifying picture of the Prime Minister of a province being turned out for honestly trying to give effect to this ideology. Another great political party wants a division of India on religious ground, forgetting all the needs of economics, and industrial development.

DEVELOPMENT OF SCIENTIFIC WORK AS A TRADE*

P. M S BLACKETT,
PRESIDENT, ASSOCIATION OF SCIENTIFIC WORKERS,
GREAT BRITAIN

THE founding of the Association of Scientific Workers of India under the distinguished presidency of Pandit Jawaharlal Nehru should prove an event of great importance for the future of Indian Science The A Sc.W. of Great Britain, of which I have the honour to be President at the present time, has asked me to convey to you its pleasure at this event and its best wishes for a rapid growth and successful development

Associations of scientific workers of this kind are a relatively new phenomenon, and it may be worth while to spend a little time discussing some of the historical developments which have brought such bodies into being,

It is usual and on the whole sound to place the beginning of the scientific epoch in which we now live as taking place in the countries of Western Europe during the 17th century Of course science did not arise then out of the blue but had a long previous history over many centuries and even millenia, intimately related to the contemporary currents in social life But certainly during the 17th century, science developed as a technique and a philosophy into something like its modern form This epoch saw the first organizations of scientists In particular, the Royal Society of London (1662) was founded by a group of those interested in the development of science and the scientific method, and in its application to the benefit of man. The men who made the tremendous scientific advances of the 17th century, were few in number and were either in the main men of independent means, or merchants, landed gentry, minor aristocrats, civil servants, or occasionally university professors An organization such as the Royal Society served perfectly the needs of the times It included all the relatively few scientists of the day resident in Great Britain and, in addition, a great many who were interested in science rather than themselves engaged in scientific enquiry There is no doubt that the Royal Society, and other analogous bodies in Rome, France and Germany etc., served a very valuable and unique function in establishing and propagating the methods, achievements and possibilities of science. Although the Royal Society exists to-day in much the same form as two centuries ago and fulfils an important function in the scientific life of Great Britain, the scale on which science is now prosecuted has increased out of all recognition, since the time of its formation.

The few dozen or so scientists in Great Britain in the 17th century have grown to a large profession, which at the present time probably comprises some 50,000 men and women. Few of these are of course great creative scientists, but all are essential to a technically progressive industrialized State. This new situation clearly demanded new organizational forms among scientists themselves, and these forms soon appeared. For understandable reasons the Royal Society did not make any radical change in its character to fit the changed circumstances but remained still a relatively small body, now of some five hundred Fellows , thus it included only the most distinguished scientists, the great majority being now either professors or heads of research institutes The need for wider bodies, more representative of the increasing numbers of junior scientists, many of whom could never hope to become Fellows of the Royal Society, and the need for more specialist bodies covering narrower fields than those covered by the Royal Society, which are the whole of the natural sciences, was increasingly felt towards the end of the 19th century. As a result, two distinct types of body grew up, one being the specialized scientific societies concerned with the publication of specialist journals and the organization of scientific meetings etc , and the other being more professional bodies concerned mainly with questions of professional organization, training and status. The Physical Society of London, founded in 1874 and now with 1400 members, on the one hand, and the Institute of Chemistry, founded in 1877 and now with 10,000 members, on the other, are examples of these two types The distinction of function was not always clear and in some cases both functions are to some extent exercised by the same body. Such bodies fulfilled a very valuable function and of course covered a far wider section of the scientific world than does the Royal Society.

By the end of the 1914-18 war, Great Britain had become conscious that not only her safety in war, but her prosperity in peace depended on the health and vitality of her scientific life, and particularly that a great increase of applied research was essential. Now applied research in Great Britain is mainly carried out in fairly large research establishments run either by the Government or by industrial

* The text of the address delivered by Prof. Blackett on the occasion of the inauguration of the Association of Scientific Workers of India in Delhi on January 7, 1947.

firms where physicists, chemists, engineers and others, may all be found working in close collaboration, together with large numbers of highly trained technicians, such as mechanics, glassblowers or chemical analysts. It was natural that scientists and technicians in such a situation should feel the need for an organization embracing them all which would be able to represent their collective view on matters of salary, status or conditions of work. A further need arose for a body which would concern itself actively with the application of science to the benefit of the people as a whole, for it became increasingly clear that the welfare of science itself depended on its fertile application to the material needs of man Though the great academic scientist in his university laboratory may have been actuated to make his discoveries solely by the stimulus of personal curiosity, it was never in doubt that the great expansion of applied research in the first decade of the 20th century had a largely utilitarian origin Thus the professional trade union aspect of the scientific profession, that of status, salary and conditions of work, became linked with the social relations aspect, that of the relation of science and, so of the scientist, to society as a whole

Clearly none of the existing bodies could fulfil these needs. A new body was required and gradually developed. Through various vicissitudes of fortune, with changing bias and one change of name since its initial formation in 1918, the Association of Scientific Workers has evolved to meet these needs Now with 17,000 members, over one half of whom are fully qualified scientists and the rest technicians and students, the A.Sc.W. attempts to serve both the well-being of its members by what amounts to trade union activity, and society as a whole by concerning itself with the impact of science and scientific discovery on society. In both these aspects, the A.Sc.W made a decided break with the older scientific organizations. Neither the Royal Society nor the professional institutes concerned themselves with specific salary questions even of the more senior scientific workers, and certainly took little or no interest in the salaries and conditions of work of the lower paid scientific workers and technicians Again the older bodies were politically neutral, that is they would not as a body express any view that could be considered controversial in the political sense. They were thus debarred as a body from taking any definite line on many matters of intimate concern to scientists and in particular debarred themselves from following up the social implications of many scientific discoveries except in the most general manner. Behind the non-political character of the older organizations lay, of course, much social history, dating back even to the 17th century, when the Royal Society was founded in the aftermath of the Civil War. But the fact is that in the first decades of the 20th century the majoriy of the members (particularly the senior ones) of the older scientific organizations were in fact as soundly conservative as the rest of the professional middle classes Now the younger scientists, both in the universities, in industry and in Government employ, were increasingly coming to the view that their interests as scientists as well as the interests of the country as a whole, lay with the programme of the socialists, or at any rate of the progressive political parties It was roughly speaking scientists with 'left' political views who joined the A Sc W , and it would be certainly true to say that now with a Labour Government in power, the majority of members of the A Sc W would consider themselves as supporters of their general policy, while equally clearly the majority of the senior scientists in the older professional bodies support individually the policy of the Opposition.

In 1942, the A ScW , after a full discussion throughout its branches, democratically decided to affiliate to the Trades Union Congress This step finally lined up the A Sc.W , with the interests of the organized workers of Great Britain, and represents in my view an important step in the evolution of the political consciousness of the scientific workers of my country.

While the British political scene as during the 19th century was dominated by two predominantly middle class parties, Liberals and Conservatives, the political views of the scientists, who were anyhow very few in number, were of little consequence With the rise, however, of the Labour Party based mainly on the working class, a danger arose that the now numerous scientists would as a class drift into solid opposition to the Labour movement in the field of politics and on the industrial plane on to the side of the employers, as against the workers And reciprocally the suspicion latent in the working class movement that the main effects of science were to cause unemployment, and that the scientist was inevitably an ally of the boss, needed much work to eradicate

In other countries where Associations of Scientific Workers have grown up, few are at present Trades Unions, and in general for sound reasons. But in Great Britain of the 1940's, the situation was ripe for affiliation to the Trades Union Congress. I personally am proud to have been the first professional scientist to be a delegate to the Annual Trades Union Congress.

From this analysis one sees that the constitution and organization of an A.Sc W. must be adjusted to the special conditions of the country in which it is formed. The main problem is to find the organizational forms which will produce maxi-

mum effectiveness in action If the aims are too narrow and the membership too sectarian in spirit, such an organization will remain small and unrepresentative of the wide range of scientists. On the otherhand, if the aims are too general and the membership too all-inclusive, it will be unlikely to show great activity and there will be a danger of it becoming an academic body unable to make up its mind on any matter of social importance Somewhere between the Scylla of narrow sectarianism and the Charybdis of wide academic neutrality, each country must find its own best course to steer

During 1946, an important further development took place A World Federation of Scientific Workers was constituted to bind together and to give mutual help to all the national bodies of the general type of the British A.Sc W. This body should be able to give much useful help to the Indian Association of Scientific Workers

Perhaps some of these remarks on the historical development and background of the British A.Sc W. may be of use to you Indian scientists who have the responsibility of building up your own organization Your social situation is in many ways quite different but the task of applying science for the benefit of the mass of the population is still more urgent The possibilities and the tasks are immense. I believe the A Sc W of India can do much both to open the eyes of the country to the scientific possibilities, and to help appreciably to realize them

JOURNEY THROUGH THE SOLAR SYSTEM

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FROM time immemorial the depths of the universe have fascinated poets and astronomers alike Each expedition into remote space has led to new discoveries An astronomer now feels like Saul "who went out to seek his father's asses but found a kingdom" In order to make a cosmographical survey of the heavens let us take a trip into the depths of space in a fictitious conveyance with the maximum speed which a material particle can possibly have

Our nearest neighbour is the moon which is at a distance of about 240,000 miles from us If our engineers are able to construct a railway track from the earth to the moon, we shall be able to finish our journey in 200 days if we travel in a mail train running continuously with a speed of 50 miles per hour Those who are used to modern conveniences would perhaps like to charter an aeroplane provided that it is possible to fly through almost vacuous space to the moon. An aeroplane moving with a speed of 500 miles per hour would take us to our nearest celestial neighbour in 20 days It is too slow a speed for reaching much more distant bodies. If we are able to construct a rocket and develop in it the maximum speed possible, *i.e.*, the speed of light which travels at the rate of about 186,000 miles per second, we shall be in a much better position for making a survey of the heavens.

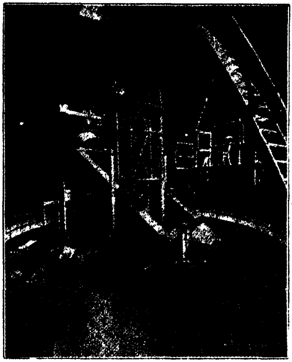
OBSERVATORIES

If we want to travel in a train, we have first to go to a railway station to commence our journey, if we decide to fly in an aeroplane, we have to go to an aerodrome So if we decide to travel through space in a celestial rocket, or a "Spatoplane" (if we coin a new word) with the speed of light, we shall have to go to an observatory to commence our journey

Mount Wilson Observatory in California, U.S A, is still at present the biggest Observatory in the world containing a telescope having a reflecting mirror with a diameter of 100 inches. It admits 250,000 times as much light as can enter an unaided eye A still bigger Observatory has recently been erected at Mount Palomar (vide SCIENCE AND CULTURE, Vol. XI, No 8) in California It will contain a reflecting mirror of 200 inches diameter which will admit 1,000,000 times as much light as can enter the unaided eye

In India, unfortunately, there are only two Observatories worth mentioning, *viz.*, Kodaikanal Observatory, Madras, and Nizamiah Observatory, Hyderabad. In the United Kingdom, having a population of about 50 millions, there are 17 observatories maintained by Government, universities and private endowments. In the United States of America and

in Russia the number of observatories is much larger. On the same scale as that of the United Kingdom, India should have at least 130 observatories



The 100-inch Hooker Telescope of the Mt Wilson Observatory
—Astronomy —Russell-Dugan-Stewart

Inter-planetary Flights

The idea of flying to the moon or to other planets is not new. Jules Verne conceived of the idea and wrote his famous book "From the Earth to the Moon" In 1928, Ensault Pel Teri discussed in detail the possibility of inter-planetary voyage (la possibilité des voyages interplanétaire) in the French Journal of Astronomy—*L'Astronomie*. Prof Ananoff who is now the president of the French Astronautic Society is busy in constructing a rocket ship which will take him to the planet Mars He thinks that it will be possible to devise an atomic engine which will control flight in inter-planetary space, so that we may fly from planet to planet and then return to earth as easily as we fly about in this world from place to place in an aeroplane. He is now trying to build a special window which will cut off ultra-violet rays and to produce metals which will resist the very cold temperature of inter-stellar space. There will also be radar equipment to keep in touch with the earth. It is noteworthy that nine girls who are at present students of aeronautical engineering at a French technical school have applied to Prof. Ananoff to be included in the first aeronautical ship to go to Mars

The Moon

With the speed of light, we shall reach the Moon in one and one third second There is neither life nor vegetation nor atmosphere in the moon It is most surprising that in spite of his much vaunted knowledge, how credulous man is in many matters! More than a hundred years ago, a little known New York news-paper perpetrated the great "Moon hoax" The editor of the news-paper had a sudden brain wave to increase its circulation It published a series of wholly fictitious articles and described the Moon as seen through a giant new telescope erected somewhere in the wilds of Africa These articles described falsely trees of amazing growth, and weird animals of immense size These fraudulent descriptions increased the circulation of this newspaper so much that it soon claimed to have the largest circulation of any paper in the world at the time

The surface gravity on the Moon is about 1/6 of that on the earth If a good sportsman can clear 5 feet in high jump here, he will be able to clear 30 feet on the surface of the moon If he can cover 20 feet in long jump he will be able to cover 120 feet on the surface of the Moon It is a good news to one who, like the fat boy of the "Pickwick Papers", has an overdose of corpulence due to the cultivation of the art of Gastronomy without moderation He would feel quite agile and frolicsome on the Moon's surface

On the surface of the Moon, we would find rugged rocks, extensive deserts, high mountain peaks, long chains of mountains, and big craters of extinct volcanoes No life can thrive or exist there.

The Sun

Let us now leave the surface of the Moon and proceed towards the Sun. In about eight minutes and fifteen seconds, we shall reach the Sun after travelling through 92 million miles with the speed of light. The Sun has got an effective surface temperature of about 6000° Centigrade, and at the centre of the Sun the temperature may be well nigh 20 million degrees Centigrade, and the pressure at the Sun's centre is of the order of several million times that of the earth's atmosphere.

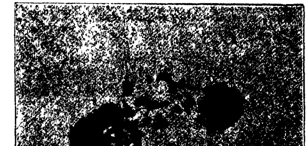
Apart from the explosion of the atomic bomb, it has not yet been possible to produce in the laboratories on the earth a temperature even equal to that on the surface of the Sun. The blue flame of a spirit stove may give us a temperature of 500°C. or so. The white filament of an electric bulb may reach a temperature of 2000°C., and the furnace for smelting iron may attain a temperature of 1800°C.

A "Carboniferous" animal will be burnt into ashes when he reaches the surface of the Sun. A "Silicaceous" animal, if any such being exists, will also have the same fate on reaching the Sun's surface. But if you enter the interior of the Sun and try to reach its centre, you will be simply "disatomized" (to coin a new word) instead of being burnt into ashes. Ashes contain separate atoms and molecules but under the influence of the high temperature prevailing in the interior of the Sun, specially near the centre, no atoms or molecules can exist as such—each atom or molecule of your body frame will be totally disintegrated as you proceed towards the Sun's centre, and the electrons, protons and neutrons thus liberated, will begin to wander at random within the interior of the Sun.

On the Sun's surface solar prominences or huge fountains of flame sprout out like Jack the Giant Killer's "bean stalk", with the speed of thousands of miles per minute.

The Sun-spots

Numerous Sun-spots are observed on the surface of the Sun's disc. They appear darker relatively to the surrounding regions on account of their lower temperature (3000°C). Gases issue out of these spots—which is perhaps responsible for the lowering of the temperature. Formerly it was thought that the Sun-spots were nothing but hydro-dynamical vortices



The great Sun-spot group of February 8, 1917
[The earth, in its relative size, represented by the black disk in the corner]
— Astronomy—Russell-Dugan-Stewart

The Sun rotates with different angular velocities in its different regions, the rotation being somewhat slower in the equatorial region than in the polar region. The difference of rotational velocities produces whirls on the Sun's surface. Similarly the differences of velocities of water currents produce whirls or vortices on the surface of streams and rivers. But as this theory cannot explain why strong magnetic fields accompany the Sun-spots, it has to be discarded. Recently the Swedish astronomer Alfven has suggested that whirl rings are created in the solar core near its centre and proceed along the lines of force of Sun's general magnetic field as "magneto-hydrodynamic waves". He maintains that the strong-magnetic field associated with the Sun-spots can thus be explained.

Solar Energy

At a temperature of 6000° Centigrade no material can exist in a state other than gaseous, and the chemical bonds of all complex compounds will be broken. So even on the surface of the Sun, all the substances are in a gaseous form consisting only of a mechanical mixture of pure elementary substances.

Due to radiation, the Sun is losing heat at a tremendous rate, *i.e.* at the rate of 3.8×10^{33} ergs per second. One would expect that the Sun is continuously getting cooler. But instead of getting cooler, the Sun is perhaps getting slowly hotter. For over a billion years the Sun more than maintained its temperature. Now the question is: Whence does the Sun get so much heat which more than compensates the loss due to radiation? Helmholtz, the German physicist, suggested that in the beginning the Sun was a giant ball of cool gas much larger than its present size. Now, due to its own weight, the primitive Sun began contracting rapidly. The progressive contraction caused a steady rise in temperature, till the loss due to radiation was balanced by the heat derived from gravitational energy liberated by contraction. But a little mathematical calculation will show that such a balance is not possible. The total amount of gravitational energy that could have been liberated by the contraction of the Sun from its primitive size to its present radius is only 2×10^{47} ergs whereas the Sun must have radiated during the period at least 24×10^{50} ergs of energy, *i.e.*, about 1000 times more energy. Hence there must be some other more powerful source of energy to maintain solar temperature. So the source must be subatomic. Atomic explosions must be constantly occurring in the Sun. One element is being transformed into another with tremendous liberation of energy. Dr Hans Bethe, the American physicist, attended the Conference on Theoretical Physics at Washington in 1938. Here he learnt about the importance of nuclear reaction as a source of solar energy. After the Conference when he was returning

home to Cornell by train he said to himself "I must surely be able to figure it out before dinner". He took out a piece of paper on which he began to write numerous formulae and numbers to the surprise of his fellow passengers. He got the correct solution at the very moment when the first call for dinner in the dining car was announced. So he did not have to miss a good meal. Bethe found that the transformation of hydrogen into helium as induced by a high temperature of 20 million degrees through the catalytic action of carbon and nitrogen would exactly liberate the same amount of energy as is actually radiated by the Sun The nuclei of carbon and nitrogen are being regenerated in this cyclic reaction and act only as catalysts The cycle is completed in five million years The cyclic reaction will go on until all the available hydrogen in the Sun is converted into helium

The Future History of the Sun

George Gamow has pointed out that helium is less transparent to radiation than hydrogen So the more helium is produced, the more opaque the solar blanket becomes Therefore, there is greater accumulation of energy resulting in a corresponding rise in temperature and increase in energy production The solar radiation is gradually increasing now, and in about 10^{10} years (ten billion years), it will have increased a hundredfold when the whole of hydrogen will almost have been converted into helium

The surface temperature of our planet will rise above the boiling point of water, and the oceans and seas will be evaporated, and terrestrial atmosphere will be surcharged with water vapour We need not have sleepless nights now because those unpleasant days will not occur within next few million years Perhaps by that time, man will begin to dig underground air-conditioned rooms or migrate to some more remote planet where conditions will be more congenial to the existence of life. When the hydrogen content in the Sun will all be exhausted, the Sun will begin to cool down and contract rapidly In about the year A D. 10,005,000,000, it will have the same luminosity as at present. The Sun will continue to shrink in size and diminish in luminosity, till it becomes a "White Dwarf Star". The radius of the dwarf Sun will be comparable to the radius of the Earth. The matter in the interior of the Sun will be so dense that one cubic centimetre of the material in its central regions will weigh about 30 tons.

Mercury and Venus

From the Sun we now go to Mercury, Sun's nearest planet. Mercury presents always the same face towards the Sun, so its period of rotation is equal to its siderial period of revolution round the Sun. On the Sun-lit side the temperature may rise above 410°C. As no heat can reach the dark-side except by conduction through the rocky core, the temperature on that side may be only a few degrees above the absolute zero. So Mercury has the dual personality of being at the same time the hottest and the coldest planetary member of the solar system. Mercury's main contribution to science is that the motion of its perihelion furnishes one of the three astronomical proofs of Einstein's general theory of relativity.

From Mercury we reach Venus. It is called "the evening star" and also the "morning star". Except for the Sun and the Moon, it is the most brilliant body in the sky. Venus has a thick atmosphere containing an enormous amount of carbon-dioxide but there is no water and no oxygen in it.

Mars

From Venus, let us travel to Mars At the end of the last century and in the beginning of the present century, an astronomical battle was raging between two groups of astronomers, and Mars was their battlefield One group of astronomers led by Schiaparelli, the Italian astronomer, and Lowell, the American astronomer, asserted that the so-called "Canals" observed on the surface of Mars were really artificial waterways made by intelligent beings. The opposing group maintained that the "Canals" were not narrow straight markings but a succession of diffuse and discontinuous smaller markings.

Mars is most favourably situated for observation when in its orbital motion it comes nearest the earth, *i e.*, about 34,600,000 miles from the earth. The planet's surface is ruddy or orange coloured and about three-eighth of it covered by darker regions of greenish colour. At the two poles there are brilliant white patches which are called "polar caps". The reddish areas do not undergo any seasonal changes. The polar caps vary in size regularly with the seasonal changes. In mid-winter each cap has its largest size and in mid-summer the cap shrinks to its smallest size. Most probably the caps are composed of snow which melts in summer.

Both Schiaparelli and Lowell announced that they observed dark and straight canals (15 to 20 miles wide) more than 400 in number on the surface of Mars. About 50 of the canals were double. They also found about 200 dark-spots or oases where one or more canals met.

Lowell also made the suggestion that the canals were perhaps waterways constructed by intelligent

Martians to bring water from the melting polar caps with the advent of summer to arable lands in the milder zones. Lowell also claimed to have observed that with the melting of polar caps the canals darkened progressively. It is quite possible that the darkening of colour is due to the growth of strips of vegetation on the two sides of the watercourses. Similarly, if there be an intelligent observer on the Moon, to him the valley of the Nile would appear as a green strip across the yellow desert of Sahara.

On the other hand, Bernard of America and other astronomers could not find any system of straight geometrical lines, but they saw only "short, diffuse, and hazy lines running between several of the small and very black spots which abound in this region". Antoniadi, the French astronomer, came to the conclusion after careful observation at Meudon Observatory that the canals were neither straight nor uniform, and they could sometimes be resolvable into succession of finer details Even in the case of most expert and careful observers, the complex, personal equation cannot be ignored It cannot be asserted that the canals are straight, artificial water courses, nor can it be said definitely that they are merely diffuse, hazy, and disconnected markings. On the above evidence we can only passs a verdict of "not proven" on Lowell's theory of intelligent life on Mars The temperature at noon in the equatorial regions may rise above 10°C, and the temperature at the poles may become as low as —70°C Martian temperature is, therefore, not unfavourable to maintenance of life similar to what exists on our earth But the vexed question of possibility of life in Mars at present has now been solved by examining the spectrum of Mars. Mars possesses some atmosphere which is much less dense than earth's atmosphere. The spectroscopic method has detected only small quantities of oxygen and water vapour in Martian atmosphere which are unable to sustain high forms of life which exist on earth's surface.

The astronomers generally accept Lowell's interpretation of the seasonal changes on the surface of Mars. Some form of vegetable life most probably exists on the dark regions of Martian surface As the polar cap melts, these regions perhaps receive their moisture from the melting snow, and thus become green in colour. As the season advances and becomes dry, these regions change their colour and become brown or grey in their appearance.

The red regions or deserts on Mars suggest that, in ages gone by, the Martian atmosphere had plenty of oxygen and water vapour, but ultimately it lost its oxygen which might have combined with the iron rocks to produce the reddish colour.

It may be surmised that, in ages gone by, when the Martian atmosphere had sufficient supply of oxygen and water vapour, and temperature conditions were more favourable, intelligent beings might have existed on Mars. Some of the canals may be old river beds or old artificial waterways—but this is all conjecture

Jupiter

But let us now leave Mars and travel towards Jupiter, the dominating planet In our journey through the large gap between Mars and Jupiter we shall come across numerous asteroids or small planets, of which none has a bigger diameter than 480 miles. We shall reach Jupiter from the Sun in about 43 minutes Jupiter is the biggest planet having a mean diameter of 86,720 miles It is about 317 times as heavy as our Earth It has got a very dense atmosphere The author calculated and found that the height of effective homogeneous atmosphere on Jupiter is about 19 kilometres Jupiter's atmosphere contains chiefly hydrogen, ammonia and methane.

So far eleven satellites of Jupiter have been discovered All the dynamical problems associated with the solar system are reproduced on a miniature scale in the satellite system of Jupiter Jupiter is indeed the dominating planet of the solar system, and recently it has achieved considerable additional importance from another source An atom is a miniature solar system, in which the electrons revolve round the positive nucleus in orbits. The Indian astrophysicist, D. S Kothari, has shown that a pressure greater than 150 million earth's atmospheric pressures will crush an atom, destroying the electronic orbital shells, and releasing electrons from positive nuclei with the result that all these elementary particles would begin to rush in disorder through space This great pressure acting from all directions would squeeze together the elementary particles, diminishing the size of the body and increasing its density An increase over this critical pressure will lead to a corresponding decrease in size and increase in density.

Under normal pressure, or more correctly any pressure less than that of 150 million atmospheres, the structural forces of an atom would resist any attempt to demolish its electronic shells or to squeeze it into an adjacent atom Under the above conditions, a solid or a liquid body in which the molecules are touching one another is practically incompressible The pressure at the centre of the earth is equal to that of 22 million atmospheres This is the maximum pressure possible on earth, and so we say that, under terrestrial conditions, a solid or liquid body is practically incompressible.

The pressure at the centre of Jupiter is equal to about 150 million atmospheric pressures. This is just below the critical pressure necessary for crumbling away of atoms. Thus we can say that Jupiter represents the largest size of solid or liquid matter that can exist in the Universe.

A solid or liquid sphere more massive than Jupiter will have internal atomic collapse with the result that its ultimate radius will be smaller than that of Jupiter. Theoretically the more massive a body is, the smaller will be its ultimate radius. Actually a stellar body which is very massive may be divided into smaller pieces due to the increase of angular rotation on account of shrinkage, or it may explode and become a nova or supernova. Our Sun, when it will become dead, will have a diameter much smaller than that of Jupiter Indeed the radius of the "dead sun" would be comparable to that of the earth It need hardly be mentioned that so long as the solid or liquid bodies are less massive than Jupiter, the size would increase in direct proportion to the mass as the atoms comprising them would be in the ordinary uncollapsed state

Saturn

From Jupiter we now proceed to Saturn, the second largest planet of the Solar System. Saturn, with its ring system and nine satellites, is perhaps the most beautiful of all the innumerable celestial objects that may be observed through a telescope.

Roche, the famous astronomer, showed in 1850 that if a liquid satellite of the same density as the parent planet comes within a distance of 2 44 times the planet's radius it will be torn into bits by the tidal forces. These bits will ultimately become solid particles which would be prevented from coalescing into larger masses by the same tidal forces. The broken satellites would thus form a ring system round the parent planet The radii of all the three rings of Saturn are well within "Roche's limit" and less than 2·44 times the planet's radius

Due to the friction of the solar tides the earth's rotation is getting slower, and the Moon is at present receding from us The Moon's distance from the Earth will continue to increase until the siderial day becomes longer than the lunar month. The effect of the lunar tides will then preponderate and the Earth's rotation will be accelerated. The Moon will then begin to approach the Earth and ultimately will come very close to us. When the Moon comes within the Roche's limit, it will be torn to pieces by the tidal forces and will form a ring system around the Earth It is for the poets to say whether for their poetic themes they would prefer to have a beautiful ring round the Earth or the sublime glory of the full Moon.

Uranus, Neptune, and Pluto

On leaving Saturn we proceed on our journey towards Uranus, Neptune and Pluto. Uranus and Neptune are like a pair of twins as they are very much alike in mass, density, size, and in physical constitution as well. Uranus was discovered by Herschel The discovery of Neptune was the greatest triumph of mathematical astronomy since Newton had discovered the law of gravitation. Adams, the Englishman, and Leverrier, the Frenchman, equally share the credit of predicting the discovery of Neptune by mathematical calculations. Johann Galle actually discovered the planet at Berlin on the night of September 23, 1846

Let us look back on the Sun from Neptune. The Sun will have an apparent diameter almost equal to that of Venus when it is nearest to the Earth. The Earth receives 900 times as much light and heat from the Sun as Neptune receives. Neptune's sun light is 500 times more intense than full moonlight on earth. In other words, Neptune receives as much light from the Sun as a spot, which is at a distance of ten feet from a thousand candle-power electric lamp, will receive from the latter.

From Neptune we go to Pluto, the gate keeper of the Solar System Pluto is at an average distance of a little more than 3,600,000,000 miles from the Sun and it would take us about 5½ hours to reach Pluto from the Sun with the speed of light.

The American Astronomer, Percival Lowell, first predicted the position of Pluto William Pickering, another Astronomer, also calculated the possible position of the new planet. But the planet was actually discovered near the star Delta Germinorium at the Lowell Observatory, Arizona, on March 12, 1930. The planet was named Pluto as it moves in the outer regions of darkness. Moreover the first two letters are the initials of Percival Lowell to whom goes the credit of the first prediction of its existence by mathematical calculations. Now we have reached the outskirts of the Solar System. As we leave the Solar System we meet nothing but dust and cosmic radiation for four years and a quarter till we reach the nearest star, Proxima Centauri.

Our Solar System may be compared to a city and its suburbs Outside the suburbs we get wide tracts of uninhabited region till we come to the nearest celestial city, *i.e.*, the nearest star. The distance of the nearest star, Proxima Centauri, is about 25 trillion (25×10^{12}) miles from the Sun. We shall undertake our tour outside the Solar System on another occasion. Let us now return to our mother Earth after a strenuous journey through different parts of the Solar System.

SUGARCANE AND THE SUGAR INDUSTRY IN INDIA

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INDIA is the largest producer, the second largest consumer and until recently the largest importer of sugar in the world. Next only to the textile industry, the Indian sugar industry is her second largest, producing more sugar than any other country in the world (*i e*, less than one-fourth of the world's cane sugar) and possessing nearly half the world's sugarcane area.

Apart from the 20 million cultivators of sugarcane, the refining industry itself gives employment to more than 120,000 workers, of whom about 3,000 are technical graduates, with another 15 millions directly interested in it.

While it is true that India has reached a stage of self-sufficiency, one has to bear in mind the very low *per capita* consumption of sugar in this country when it is compared with the *per capita* consumption in other parts of the world (based on 1937-38 figures) *viz.*:—

Denmark	.. 121 2 lbs	Germany	. 59 0 lbs.
Australia	116 6 ,,	France	. 54 5 ,,
Sweden	.. 106 5 ,,	Brazil	. 52 6 ,,
Canada	. 102 7 ,,	Mexico	. 33 4 ,,
Great Britain	.. 101 3 ,,	Russia	. 29 0 ,,
U. S. A.	95·5 ,,	Poland	28 8 ,,
Switzerland	93 0 ,,	Japan	.. 24·4 ,,
Cuba	83 6 ,,	Spain	... 22 7 ,,
Argentina	74 1 ,,	Italy	.. 20 0 ,,
Belgium	.. 70 2 ,,	India	. 18·3 ,,
Netherlands	.. 64 2 ,,	Java	.. 10 3 ,,
South Africa	.. 60 7 ,,	China	4 6 ,,

Prior to the grant of fiscal protection to Indian sugar industry, India was still in an anomalous position of being at the same time the world's second largest grower of cane and one of the greatest importers of manufactured sugar anxiously awaiting for her sugar supplies from Java. In 1929-30 India imported 940,000 tons of sugar valued at Rs. 15·5 crores from Java. Within four years after protection the output of factory sugar increased enormously and but for conditions brought about by war and other exceptional factors beyond control, she would have been an exporting country.

Although some fourteen years have elapsed since protection was first granted to the sugar industry, it has not yet a secured position.

In the beginning of the present decade the problem was one of over-production. Now, it is a problem of under-production. The problem of over-production was indeed so acute that as late as 1940-41 and 1941-42 production of sugar in factories was restricted to a maximum quantity by law. But there was a dramatic turn of the situation in 1942-43 when the shortage of supply was first felt and government raised the slogan of maximization of production.

The chequered career of the Sugar Industry in India provides a unique example of the way in which multifarious factors: science and technique, practical agricultural methods, government tariff and transport policy, and trade conditions—have to be coordinated and manipulated—in order that the industry may not fall into decadence, but may flourish and grow and provide employment.

SUGAR-YIELDING SPECIES

Sugarcane belongs to the genus *Saccharum* Linn, a small genus of perennial grasses containing about 35 species and found in the tropics of both hemispheres, but chiefly in the old world tropics (Asiatic). The delimitation of the genus from the allied genera has undergone changes recently as a result of the investigations carried out at Coimbatore (India)

The present conception of *Saccharum* favours its being split up into three separate genera, *viz*, (1) *Saccharum* Linn, (2) *Narenga* Bor and (3) *Sclerostachya* A Camus

The genus *Saccharum* includes:—

1. S. *arundinaceum* Retz—Wild in India, Malaya and China but according to Parker, this only occurs as a cultivated plant. This is now separated from *Saccharum* and placed under *Erianthus*.

2. *S Spontaneum* Linn—(The Kans Grass). Grows wild and is cultivated nowhere but the sugar industry in India and Java has benefitted greatly by utilizing it in breeding. Distributed in the tropics (old world) this is a very variable grass and the Indian forms are a polyploid series with chromosome numbers ($2n$) varying from 27 to 80. Parthasarathy and Subba Rao working at Coimbatore on the cytology of *S. Spontaneum* found that the forms with smaller numbers ($n=27$) are found in North and North-West regions of India and as we proceed eastwards the forms with $n=32$ and $n=36$ (Bihar), $n=40$ (Assam), $n=48$ (Burma), $n=50$ and $n=56$ (East Indies) are met with thus indicating the above geographical trend. Still more primitive forms are thus likely to be found further west (Dutt, 1947).

3. *S. Officinarum* Linn—(The Sugarcane). Include the introduced thick class of canes which are of tropical origin. They were imported into India about a century ago and is now in cultivation in

limited scale not only in the tropics but far beyond them. It is one of the chief source of sugar at the present time. Native of East Indies.

4. *S. Officinarum & S Spontaneum.*—Parthasarathy from his cytological studies is of the view that the indigenous Indian canes might have evolved from an extensive hybridization between *S. Officinarum* and *S. Spontaneun*

5. *S Barberi* Jesuviet—includes the indigenous cultivated canes of India Barber adopted tentatively five well-defined groups, *viz.*, "Mungo" (24 varieties): "Saretha" (17 varieties); "Sunnabile" (15 varieties), "Pansahi" (12 varieties); and "Nargori" (12 varieties).

6. *S. sinensis* Roxb includes the cultivated varieties known as China canes. Native of China and introduced into the Royal Botanic Garden, Sibpur in 1796 This was hardier and better than local varieties.

Narenga is now a separate genus and *Saccharum narenga* Buch-Ham, is now *Narenga porphyrocoma* (Hance) Bor. Similarly, *Saccharum fuscum* Roxb and *Saccharum ridleyi* Hack are *Sclerostachya fusca* and *Sclerostachya ridleyi* respectively.

The Antiquity of Sugarcane

It is unanimously agreed that India is the original home of sugarcane and her sugar industry is at least three thousand years old. The origin of cane sugar and therefore of sugarcane dates back to the earliest history and reference to it is even found in Hindu mythology, where Viswamitra, is attributed to have created sugarcane in the temporary paradise of King Trisanku, use being granted to the mortals only after the destruction of that paradise.

Nomenclature.—The etymology of the generic name *Saccharum* given to the sugarcane by Linnaeus in 1753, can be traced back to the Sanskrit word *Sarkara*, meaning gravel or 'gritty particles'. Later the word came to denote sugar crystals In the 'Prakrit' or popular language, the word was written as *'Sakkara'* and when the Arabs introduced sugarcane from India *via* Iran it became *Sakkas* and eventually *Sakkar*. When the Greeks introduced sugar from Asia Minor they adopted the name to their language, sugar being known in ancient Greece as *'Sakchar'* or *'Sakcharon'*. The Romans in turn, took the word from the Greeks writing it *Saccharum*

The knowledge of converting saccharine juice into the crystalline form was much later than the *Vedas*. The word, *ikshu*, 'sugarcane' occurs in *Atharva Veda* of the Hindus (1000 B.C.) and it is interesting that an ancient royal family celebrated in the epic *Ramayana* and the *Puranas* had the epithet *Iskshaku*. The question arises whether the Vedic aryans cultivated the cane or knew it as a weed. We have, positive evidence of the cultivation of the plant and manufacture of *gur* in India for at least three thousand years. (Chowdhury, 1937; Ray, 1918).

Origin and Migration of Sugarcane from India

It is from India that the cultivation of sugarcane spread to the other countries in course of time. Alexander the Great and his soldiers were probably the first Europeans to see sugarcane which they called the 'honeyed reed' and which they took with them when returning home from their Indian expedition (327 B C.) Strabo, the Greek geographer (1 B.C.) vaguely described the plant as the Indian honey-bearing reed The propagation of sugarcane in Western India was thus well known to both Greek and Roman writers Even Dioscorides (before Pliny) speaks of a grass from which a kind of honey was secured in India and Arabia

The Chinese, who have been making cane sugar for some 3000 years consider that sugarcane came to them from the west Chinese writers of the eighth century B C have recorded that knowledge of the sugarcane and its products were derived from India.

The Chinese Emperor Tsai Heng (600 A D.) sent agents to Bihar, to learn the art of sugar manufacture, perhaps the first instance on record of a technical commission investigating manufacturing process in a foreign country

Until the fifth century A D sugarcane did not escape beyond the western countries of India, excepting Arabia It progressed towards the west at a very slow rate In the fifth century A.D, the cane was cultivated in Iran In 641 A D., the Arabs took it to Egypt and later to Spain.

The progress to the west before 641 A.D was very slow and appears to have been held up near the Indus for 800 years Between Alexander's invasion in 326 B.C. when the Greeks learned of the sugarcane and escape into Iran of a sugarcane industry in the fifth century A.D., there appeared a barrier of the inhospitable hills, of Afghanistan, Baluchistan and E. Iran, too great to be crossed earlier by field cultivation of sugarcane. There was entire ignorance of the condition of the Punjab's sugar industry. By hybridizing *S. officinarum* with *S. Spontaneum*, races of cane had been raised in India, hardier than those previously existing in these regions and this has enabled cultivation of sugarcane beyond the North-West region of India.

By the fifteenth century A.D., two well-defined centres of origin of sugarcane diversified, *viz.*, (1) *Eastern Asiatic canes* including *S. Barberi* (Indian

cane) and *S sinensis* (Chinese canes) and (2) *South Pacific Canes* including *S. Officinarum* (Fig. 1).

The Eastern Asiatic canes gradually migrated to Madeira, Canaries, and W. Africa in 1420 A.D The New World now of considerable importance in sugar, first received it at the hands of Christopher Columbus in 1493 A D. By the sixteenth century it further pushed into Cuba, Porto Rico, and W Indies.

The thicker class of canes allied to Mauritius canes must have existed in India earlier than the above-recorded introduction by Sleeman as Ibn-i-Batuta who travelled in the 13th century makes mention of the *Paunda* cane of Malabar coast. Parthasarathy working at Coimbatore states that there are references in Dravidian literature of the *Sangam* period before 2nd century A.D pertaining to sugarcane thus affording knowledge of sugarcane (probably thick canes) in South India at quite an early period. The reference in the Sanskrit literature *viz.*, *Atharva Veda*, the Institutes of Manu, etc., pertain, no doubt, to the North Indian indigenous canes (Dutt, 1947).

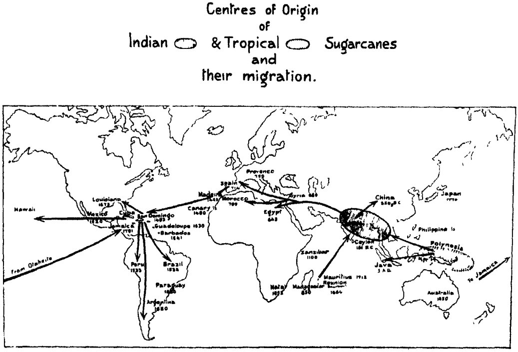


Fig 1

The South Pacific canes were carried to the various Pacific islands by the Polynesians and to Java and Mauritius by the Malayans Capt Bligh carried it from Otaheite to Jamaica in 1791 A D. and it was Capt. Sleeman who in 1827 introduced the Mauritius cane to India, and deposited them in the Botanical Garden at Sibpur (Calcutta). An account of the cultivation, etc, of these foreign canes is found in the transactions of the Agri-Horticultural Society of India and Capt. Sleeman received the Gold Medal of the Society in recognition of his experimentation and introduction of foreign canes

The varieties of sugarcane grown in India in the 18th and 19th centuries have been listed by Watt (1893) detailed as under (1) Mauritius, (1) Otaheite, (3) Bourbon canes, (4) Batavian canes, (5) China canes, (6) Singapore canes and (7) Indian canes.

Watt, however, did not attempt to classify the indigenous Indian canes as he found them to be very diversified.

Trade in Sugar (1839-1922)

During 1839-1847, India exported to England on an average 59,373 tons of sugar. Half a century later, from an exporting country, India became an importing one and the total imports of sugar were 212,000 tons of which just over half was shown as beet sugar. The area under sugarcane for the eight years preceding the enactment to countervail bounty-fed sugar in 1899 showed an annual average of 2,818,250 acres and for the eight years subsequently of 2,429,700 acres, showing that the acreage under sugarcane underwent some contraction. The countervailing duties imposed in 1899 and enhanced in 1902, to prevent the ruin of native cane sugar in-

dustry by bounty-fed beet sugar, did not diminish the volume of imports, for as the supply of German and Austrian beet sugar declined, its place was taken over by cane sugar. Mauritius which already supplied more than any other individual country, nearly doubled its shipments by 1903-04, while in the same period Java made a very remarkable advance, increasing its supplies from 7,000 tons to 56,000 tons Java continued to retain its progress during the next ten years and in 1913-14 sent 670,330 tons out of total imports of 896,000 tons, Mauritius contributing 142,000 tons only The area under sugarcane in India in that year was only 2,536,900 acres representing a decline of 8 per cent on the totals for 1890-91.

During the World War I, the apprehended shortage of supplies due to the large purchases by the United Kingdom of Mauritius and Java sugar and the rise in values while the war lasted made cultivation of sugarcane more remunerative and in 1918-19 (a recovery was made to the acreage of 1888-89), the area under sugarcane being 2,901,000 acres After the war and in spite of the protection afforded by import duty, many Indian sugar factories ceased to earn a profit and Java continued to maintain its position as chief supplier In 1921-22, 623,000 tons out of 717,600 tons cane from Java (Saksena, 1937)

Earliest Investigations

It was in 1796 that Roxburgh received for experiment a thin cane (*S sinensis*) from Canton and grew it in the Royal Botanic Garden, Sibpur, in the hope of finding it in some respects better than the common cane cultivated over India. It produced a profitable crop even to the third year, while the common cane of India had to be renewed every year It also yielded juice of a richer quality and double the quantity than that obtained from local canes

The foreign canes introduced into India, however rapidly deteriorated and manifested a steady decline in the percentage of sugar-yielding juice This led to the idea that experiments should be made to improve the Indian stock, rather than that attempts should be made to acclimatize foreign canes Leather remarked that "Undoubtedly some of the canes which is at present grown in the Madras Presidency is second to none in the world".

The systematic study of sugarcane in India may be said to date from 1901-02, when in consequence of the destruction of the crop in Madras by 'red rot', Dr Barber, started the well known 'Samalkote Farm', where efforts were made to discover 'red rot' resistant varieties. "Red Mauritius" was found to be the hardiest Arrangements were made for its distribution and by 1912 the area in the affected tract had risen from 4,000 to 9,000 acres, while the cane was also distributed in new tracts

Attempts for the improvement of cane in the early years was confined to comparison of certain canes imported from Java, Mauritius or other parts of India and multiplication of any that seemed promising No breeding work was done because the seed would not set in the North, where the cane was an important money crop, while in the South where it would set, the crop had little economic value The first problem with which Dr Barber was faced, was the introduction into the main sugarcane tract of northern India of richer canes giving higher yields, having greater resistance to disease and yet adaptable to the methods of cultivation employed by the cultivator Thus selection of better strains from the existing varieties and introduction of canes of better quality from outside were attempted.

Dr Barber found that those varieties of canes which were imported from the tropics, were not suited to the sugar tract of Northern India. What was wanted "is a more hardy type of cane capable of holding its own with the canes grown under field conditions in Northern India" and it is to the production of these types that he devoted himself

For Northern India, Dr Barber produced a superior hardy hybrid (between the local northern canes and the best southern canes), that eventually displaced the inferior local varieties. But it was soon observed that these improved canes disappeared within a short time when left to farmers, proving that field experiments on cane breeding should never be slackened if the improvement is to be maintained. The breeding investigations started by Barbar has produced a very great number of races, varying in many ways—in thickness of stem (from one-half inch to about two inches) in combination with such characteristics as colour, hardness, sweetness, height, shape of joints, pose of leaf etc In 1916, Barber as a result of his comprehensive studies, published a classification of the indigenous Indian canes, which is still the standard classification of the Indian canes (Mckenna, 1915) (Fig 2).

Coimbatore Station Inaugurated

In 1911, the late Pandit Madan Mohan Malaviya moved a motion at the Imperial Legislative Council which recommended the raising of the import duty on sugar and an important discussion took place on the promotion of Indian Sugar Industry.

Subsequently the Board of Agriculture in India at its Seventh Meeting in November, 1911, recommended that the question of sugarcane improvement should be seriously taken in hand. Public opinion was awakening to the threatened danger to the industry by the annually increasing imports of sugar from

Java. Cheap refined sugar was not only being largely consumed as such, but was being mixed with Indian *gur* in the manufacture of impure brown sugar, to give it the hall mark of *Swadeshi*.

Dr C A. Barber

The recommendations of the Board of Agriculture were accepted by the Government of India in June 1912 and the Coimbatore Cane-breeding Station, the first of its kind in India, was opened with the appointment of Dr C. A. Barber, Economic Botanist, Madras, as the cane-breeding expert. Coimbatore was selected for the work as the canes there unlike those in N. India flower annually, produce pollen and thus render possible the hydridization experiments. The agricultural problem involved a survey and testing of local varieties, the improvement of varieties by cross-breeding, and the distribution of the best varieties, manurial and cultural tests and the development of an organization for the demonstration of improvements and for extension of cultivation. Barber recognized two principal varieties of cane in cultivation *viz*, (1) the thicker canes, the true *S Officinarum* and (2) the thinner canes, supposed to be hybrids between *S Officinarum* & *S Spontaneum* He further learned that a *race* called 'katha' was locally held by Punjabi cultivators, and actually made a hybrid of this with *S. Spontaneum* demonstrating the possibility of crossing between different varieties He thus overcame the very difficult problem involved in cross-fertilization and recognized the advantage of indigenous varieties as parents instead of relying on imported varieties using the wild saccharum plant, specially *S. Spontaneum* The parent (*S. Spontaneum*) carried only 3 to 5 per cent of sugar but the hybrid obtained by crossing with it yielded 7 to 12 per cent. Barber then continued to produce entirely new varieties of

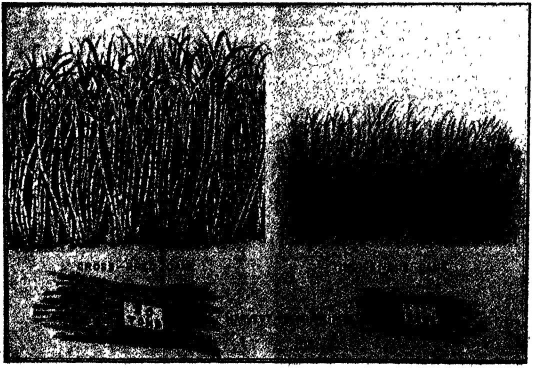


Fig. 2 Results Obtained.

great vigour and power of growth from which selections suited for various climatic and adaptive conditions could be made.

The period for which the Coimbatore Station had been sanctioned was to expire in 1916, when the Board of Agriculture in India, impressed with the good work done by Barber and his assistants and realizing the potentiality of the Station, recommended that it should be continued. An annual graent of Rs. 44,000 a year was made from the central to the provincial revenues to cover the estimated annual cost of the Station Dr Barber held charge till April 1919, when he was succeeded by Rao Saheb (now Sir) T S. Venkataraman, who was associated with him, as his senior botanical assistant from the very beginning.

Indian Sugar Committee, 1920

The position of India in relation to the world's supply of sugar led to the appointment of the 'Indian Sugar Committee" in 1919 under the chairmanship of Mr J. Mckenna, I C S (Agricultural Adviser to the Government of India) and later of Mr F Noyce, I C S. Their report published in 1920 dealt (1) with the agricultural and irrigational aspects of the problem in U P, B & O, Punjab, N W F P., Bengal, Assam, Burma, Madras, Bombay, Sind, C P, Hyderabad and Mysore, (2) with its manufacturing aspects and (3) with matters affecting the industry as a whole and its future organization.

This Committee recommended the organization of the Indian sugar industry on the Java model and the formation of an Indian Sugar Board, who would generally control amongst other things the policy of the Indian Sugarcane Research Institute at Coimbatore They further recommended the development of the latter on modern lines with three divisions *e.g*, agricultural, chemical and engineering It is only research work on cane that was to be taken over by the institute and its sub-station, the work for the distribution of improved varieies, demonstration and propaganda, were left to the local agricultural departments.

A sugar bureau which was formed in 1919 was for the purpose of collecting and co-ordinating information regarding the sugar industry and furnishing advice to cane growers and sugar manufacturers The introduction of the new varieties evolved at Coimbatore in North Bihar was due to the efforts of this bureau. The bureau, further provided the trade with the latest information on price and stocks. (Govt. Pub., 1921).

Sir T. S. Venkataraman, C.I.E. (1918-42).

The general purpose in the breeding experiments continued by Venkataraman, was to produce a range of plants from which selection can be made for various purposes, suitability to the conditions of different parts of India; resistance to various diseases or pests, earliness of maturity and high yield; and lateness without degeneration in the Indian summer.

Sir T S Venkataraman

He developed the technique, whereby the troublesome procedure of cross-fertilization is simplified and carried out more conveniently. The time of flowering was altered so that the varieties which did not flower simultaneously were made to do so, thus allowing crossing to be done

From the sugarcane breeding station at Coimbatore has thus poured out a continuous stream of new varieties, the so-called "Co" (=Coimbatore) canes, which are now widely known throughout all countries where sugarcane is grown. There is now, a Co cane suitable for every area in India, where sugarcane will grow. In addition, there has been breeding in Mysore of the so-called HM canes (HM=Hebbal Mysore).

In the course of such crossing experimentation wild species of cane have been often used as parents in order to bring in toughness of constitution and resistance to disease. The study of these wild species have revealed among them an astonishing range of form.

The breeding of thick type of canes have further yielded great economic results, certain of the resultant hybrids finding use even under sub-tropical

condition. The breeding of the sub-tropical types resulted in advances in the evolution of types to suit special conditions. Co 419 and 421 have shown usefulness as parents in further breeding Co 421 proved a heavy yielder in sub-tropical India and Co 356 as a midseason cane in Bihar.

South and western regions of India enjoy the ideal condition for sugarcane growth and thanks to certain new varieties like Co 419 and POJ 2878, some of these regions have now shown definitely that sugarcane grow better in these parts than the best sugarcane growing countries of the world.

Council of Agricultural Research for the promotion, guidance and co-ordination of the agricultural research throughout India and to link it with agricultural research in other parts of the Empire and in foreign countries.

The sugar committee of the I.C.A R., at its very first meeting in 1929 recommended the protection of the Indian Sugar Industry. The Government of India after considering the evidence adduced by the Council, decided to refer the question to the Indian Tariff Board for enquiry. A duty for the protection of the industry was proposed by the Tariff

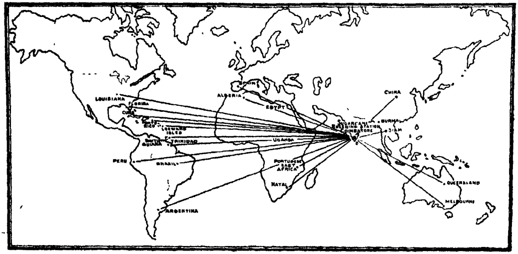


Fig 3 Countries where Coimbatore canes are reported promising

The range of parents available for crossing with sugarcane have also been extended Some of these include weeds like *Imperata* and *Sorghum halepense* These are intended to widen the range of variation and to produce new characters not available in the genus *Saccharum* Crosses have also been made between sugarcane and bamboos!

The work of hybridization has not only produced these important practical results but has been a mine of scientific discovery

Associated with this work is an intensive study of the cytology of sugarcane species and its hybrids and of the sugarcane-sorghum and sugarcane-bamboo hydrids and studies have given important indications as to the evolution of many forms.

The somewhat peculiar phenomenon of inheritance in sugarcane has been traced to the polyploid nature of most sugarcane parents and irregularities in chromosome pairing during meiosis.

INDIAN TARIFF BOARD, 1930

The Royal Commission on agriculture in India recommended in 1928, the establishment of the Indian

Board in 1931 In 1932, the Government of India, granted the fiscal protection and this year is perhaps the greatest land mark in the history of the Indian Sugar Industry (Govt Pub, 1933).

Sheltered behind the protective tariff, the industry developed its productions with considerable success and foreign sugar was rapidly displaced by indigenous sugar industry in a considerable reduction of imports as will appear from the table appended below.

Year	Quantity of Imports	Value
1929-30	941 thousand tons	1551 lakhs of Rs.
1930-31	901 " "	1054 " "
1931-32	516 " "	601 " "
1932-33	370 " "	421 " "
1933-34	261 " "	270 " "
1935-36	201 " "	—
1938-39	32 " "	41 " "
1942-43	250 tons only	—

This renaissance of the Indian Sugar Industry converting it from a country importing white sugar to the tune of a million tons into one which during

the crop year 1936-37 produced a surplus of roughly a quarter million tons resulted from two factors *viz.*, (1) the availability of raw materials resulting from improved canes which besides giving greatly increased yields also showed themselves responsive to better agricultural treatment and (2) the very substantial tariff protection

The intensification and spread of scientific investigation on sugarcane problems has been largely due to the stimulus and subsidies of the I C A R.

During the last 10 or 12 years a number of provincial sugarcane experiment stations have developed at Jorhat (Assam), Dacca (Bengal), Pusa (North Bihar), Shajahanpur (U P), Lyallpur (Punjab), Padegaon (Bombay), Anakepalle (Madras), Mysore and Karnal subsidized by the I.C A R

Much of the work at the stations, involved testing of varieties and a certain degree of stability has been reached, regarding the types most suitable for different areas Over the 75 per cent of the total area under sugarcane is now covered by improved varieties.

Until recent years, the responsibility for guiding sugarcane research in India and advising both the Central and Provincial Governments on matters relating to the improvement and development of the industry connected with sugarcane and its products rested with the sugar Committee of the I C A R.

Varietal Composition of the Sugarcane Crop in India

When the Indian Sugar Committee reported in 1919, the results of breeding work at Coimbatore were only just becoming apparent. Prior to any breeding work, India produced poor canes and she produced 11 tons per acre, when tropical canes produced 40 tons per acre. By breeding the yielding has been raised to 30 tons per acre The annual increased income to ryots by growing Coimbatore canes is estimated about Rs. 15 crores The first important group of seedling canes to be released in 1918 was a set of four Co. 205, Co. 210, Co. 213 and Co 214. Co 213 (POJ 213 × Co 291) was almost the universal cane throughout the main sugarcane belt of North India till 1939-40. It still occupies 386,000 acres *i e*, 16 6 per cent of the total area under sugarcane in India and 75 per cent of the area under sugarcane cultivation in Bengal. It is however losing in popularity on account of its susceptibility to red rot and is being replaced by other varieties

The principal other varieties now under cultivation are :—

		Area
Co. 312	(Co 213 × Co 244)	16 6%
Co 313	Co. 213 × Co 244)	8 6%
Co 285	(Green sport of stripped Mauritius)	7.7%
Co 331	(Co 213 × Co 214)	7 5%
Co 290	(Co 221 × D74)	5 7%
Co 419	(POJ 2878 × Co 290)	2 9%
Co 421	(POJ 2878 × B3412)	2 8%
Co 223	(Chittan × M1515 (Naanal × *S. Spontaneum*))	2 5%
Co 299	(Co 213 × POJ 1410)	2 0%
Co 244	(POJ 213 × Co. 205)	1 6%
Co 256	(POJ 2725 × *Sorghum durra stapf*)	0 9%
Co 205	(Vellai × S. *Spontaneum*)	0 8%

Co 312 has at present the largest area in N. India and Co 313 has also a large area because it is the main cane of N Bihar but it has a low yield.

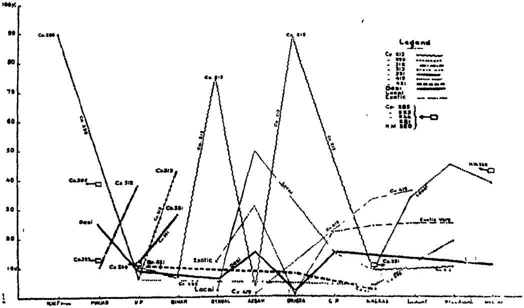


Fig 4. Percentage area occupied by important varieties in sugarcane tracts of India. 1941-42.

Co. 290 (along with Co. 281 and Co. 301) proved useful in foreign lands as well Co 290 is the recipient of the Grand Prize in Hawaii, in possessing the biggest stool ever produced anywhere with 360 canes to the stool standing 30 feet high and possessing two tons of materials with 400 lbs. of commercial cane sugar in it In India it has now the largest area in N W.F.P Co. 419 has done so well in Bombay, Deccan, and Madras (tropical parts of India).

The production of new varieties of Co canes have not ceased as yet. The 1946 batch consists of eleven canes, Co. 634 to Co 644 (both inclusive) (*Indian Farming*, 1946). Two of these, *viz*, Co 635 and Co 636 are of Co 301 parentage and in selecting them the characters of non-flowering and relatively less pith formation have been kept in view Co. 638 is an early ripening cane Co 644 possesses the rather rare combinations of good yield and satisfactory sucrose and is a promising variety. Co. 641 is a Co. 419 type of cane, not likely to lodge in areas subject to cyclones Co 639 is another sorghum hybrid and is a Co. 313 class of cane but with better yield. Another sorghum hybrid, Co. 640 is a mid-season cane of satisfactory juice quality. (Dutt, 1943)

Hebbal-Mysore canes.—The sugarcane breeding station, Hebbal (Mysore) has also been raising seedlings and some of these have got into cultivation chiefly in Mysore. HM 320 is most widely cultivated. (Figs. 4 and 5).

Sugarcane-Sorghum hybrids—Of classical importance is the work carried out at Coimbatore on the production of inter-generic hybrid *i.e.*, crossing sugarcane with sorghum. Some of these like Co. 356 appear to be promising and is adapted to conditions prevailing in the U P The hybrids ripen in a short time and maintain its juice for another 3 months.

The demand for and the spread of new varieties of high-yielding and disease-resistant sugarcane and the successful production of inter-generic hybrids, by shortening the growing and ripening periods are the aims of the breeding programme at Coimbatore.

One of the effects of the high yields given by the improved Co. canes would be the lowering of the fertility of the soil Hence, manuring of sugarcanes with oil-cakes or fertilizers has to be resorted to according to their local price and manure content Of nitrogenous manure it is estimated that sugarcane require 100 lbs. of nitrogen per acre.

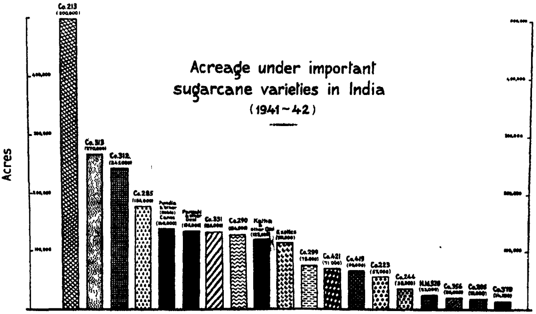


Fig 5

Desi or indigenous varieties.—These canes belong to *Saccharum Barberi* and are still of sufficient importance in certain tracts, mainly in the U.P., and Punjab Taken together they occupy about 7-8 per cent of the total area under sugarcane cultivation in India The more important of these that are still persisting in cultivation are *Katha, Panshahi, Dhau,* etc.

A large area (140,000 acres) is still occupied by the thick varieties of *Saccharum officinarum,* in Bombay, Hyderabad and Mysore. They are also

grown for chewing purposes in North India and are called *paunda*.

Exotic Varieties—These were introduced from Java, Mauritius, and Barbados from time to time and now occupy 119,000 acres in India. The most important of these are POJ 2878, White Tanna, J 247, Red Mauritius, and a few others (Govt Pub 1940)

The successful propagation of sugarcane hybrids has been possible due to the fact, that cultivation of sugarcane is effected vegetatively, thereby retaining the characters obtained by hybridization. Propagation

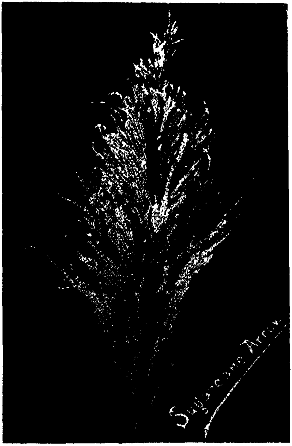


Fig. 6. Sugarcane 'Arrow'—
The basis of sugarcane breeding

by sexual methods (*i.e.* seeds) usually render successful hydridization difficult as there always remain the chance of the useful character segregating in the successive generaions.

ACREAGE AND PRODUCTION OF SUGARCANE IN INDIA (1911-41)

The graph (Fig. 7) clearly illustrates the fluctuations in the cane acreage with a continuous series of cycles of high and low acreage.

In 1913-14, the area under sugarcane declined by 80 per cent on the totals for 1890-91. Increase in acreage during World War I, was due to large purchase by U. K. of Mauritius and Java sugar and short supply in India

Till 1932, when tariff protection was given to the sugar industry, the area under cane remained *very stable* and varied within the narrow range of 2½ to 3 million acres Since the grant of protection there has been a steady rise in the curve indicating increase in production. This was due to the increased demand of the expanding white sugar industry for sugarcane.

This is apparent when it is noted that prior to 1932-33 there were only 31 cane factories in operation but 27 and 65 new factories were added during 1932-33 and 1933-34 respectively, and another 19 new factories were built for working in 1934-35, making a total of 142 factories in India, *i.e.*, an increase of 350 per cent in three years. In 1935-36, India led in the production of cane sugar, raising about 33 per cent of the world's crop of 20,037,600 tons.

Further, the Governments of U. P. and Bihar, fixed the minimum prices for sugarcane, purchased by factories, helped the growers to realize a better return on their crop and encouraged them to extend the areas under cane, and as a result the area under cane stepped up to 4½ million acres in 1936-37. There was thus an over-production of sugar in the country and the price dropped to an uneconomic level and the cultivators received very poor prices for cane. This discouraged sowing for the following season and is the cause of the rapid decline in acreage in 1938-39.

During 1943-44, 151 factories worked and produced 1,304, 106 tons of sugar as against the production of 311,000 tons by 38 factories in 1929-30.

It has been estimated that for a well-balanced diet India will have to provide 2 ozs. of sugar per adult per day, as against the present available ration of 1·0 oz. per day. According to this standard, we are still deficit in production of sugar by 1 million tons annually, the quantity available being 5 3 million tons per annum.

The present production of the industry annually averages about 10,000 lakhs tons. But a panel appointed by the government estimates India's total and potential requirements at 18·5 lakhs tons The present potential capacity of the industry is only 14 00 lakhs tons. (Govt. Pub: 1944)

To step up production to reach the target mark of 18·5 lakhs tons the government have decided to establish 20 new units immediately but in view of the present difficulty of the import of machinery etc.

these units cannot be expected to function before 1950. Meanwhile therefore, the existing gap between consumption and production is to be bridged up by increasing production in the existing factories

At the present time, only 20 per cent of the cane grown comes to the factories—80 per cent being utilized in the manufacture of *gur*, because the cane grower finds it more profitable to make *gur* rather than give his cane to the factory, when the price fixed by the government is low A proper price for cane should therefore be fixed Secondly, steps should be taken to increase the yield of cane per acre For this, new varieties of cane giving higher yields per acre and better recovery of sugar should be propagated and introduced It is significant that while the yield of cane per acre in India has steadily declined from 15 6 tons in 1936-37 to 15 0 tons in 1942-43, the percentage of recovery of sugar in the factories on the other hand has steadily increased from 8 39 per cent in 1935-36 to 10 28 per cent in 1942-43 The increase in recovery percentage has been mainly due to increased efficiency of the factories. (Burns, 1944 , Gandhi, 1942, 1945).

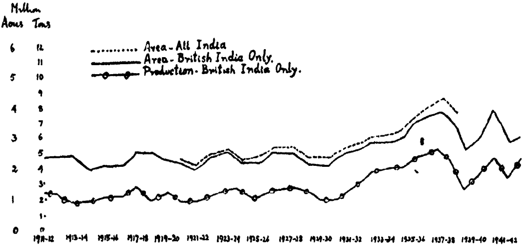


Fig. 7

INDIAN CENTRAL SUGARCANE COMMITTEE

Taking into account the expansion of its own work and envisaging considerable further development in the near future and the need for post-war re-adjustment the sugar committee of the I C.A.R. in Ocober, 1941, recommended that a central sugar committee be constituted on the lines of the Indian Central Cotton Committee and similar commodity committees. This was finally approved by the Government of India and the committee was brought into existence in 1945 with its headquarters at Delhi.

The function of this committee is to undertake the improvement and development of the growing, marketing and manufacture of sugarcane and its products and further include such items as:

(1) agricultural, technological and economic research on sugarcane,

(2) the production, testing and distribution of improved varieties of sugarcane, *gur* and their by-products,

(3) adoption of improved cultural practices and (4) improvement of crop forecast and statistics

The Government of India have further placed at the disposal of this committee a sum of Rs. 1 crore and 25 lakhs (the entire proceeds of the Sugar Excise Fund, to which fund are credited at the rate of -/1/- per cwt. of white sugar produced in British India) for the development of the sugarcane industry.

To utilize this fund various agricultural and technological research schemes were considered by this committee at its fourth meeting held in New Delhi on the 8th February 1946, under the chairmanship of Sir H R Stewart.

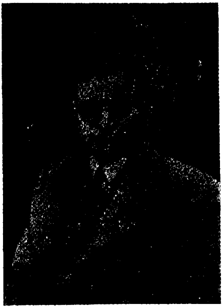
The developmental work will consist of establishment of seed nurseries, and provisions for (*a*) manures of the right type, (*b*) qualified technical personnel to carry the results of research to sugarcane growers, (*c*) an efficient watch and ward service for protection of crop against pests and diseases, and (*d*) a soil extension service to advise sugarcane growers.

The Committee further decided to finance a five-year scheme for organizing an expedition by the Coimbatore Station, to collect the various wild forms of *Saccharum Spontaneum* and the allied genera for intensive study, as also for assessing their value as breeding material.

It appears that the possibility of crossing cultivated canes with this wild grass and the production of new varieties, is not yet exhausted and the potentialities of the fresh material which this expedition would provide would be determined at the Central Sugarcane Breeding Station at Coimbatore.

SURVEY OF SUGARCANE RESEARCH . N. L DUTT

In 1942, the I.C A R. undertook a comprehensive review of the sugarcane research in India during the last decade, with a view to chalk out future lines of research in order to develop to the utmost, the potentialities of sugarcane cultivation throughout India. Sir T S. Venkataraman, to whom India owes a great debt, agreed to undertake the task for the Council. The work was later carried on



Mr N. L. Dutt

by Mr N. L. Dutt, the present Imperial Sugarcane Expert, who succeeded Sir T S., in 1942.

In this report, (published in April 1946), Mr Dutt remarks that if the work of cane development is properly carried out on the line indicated by him, so as to bridge the gap between the yields at the sugarcane stations and those realized by the average cane grower in his fifields, an average yield of 800 maunds per acre (*i.e.* about 30 tons) in U. P., Punjab and Bengal, of 600 maunds in Bihar and of about 1,100 maunds in tropical areas can be realized in a period of 5 years. If the same work be continued for another 5 years, a further increase in yield by 100 maunds can be registered in each tract. The target figure, however, should be 1,100 maunds in North India and 1,400 maunds in tropical area. It is suggested that a sum of Rupees 2 crores should be spent every year on cane development alone for the next ten years before the desired object of the stabilization of the sugar industry will be in sight.

The average per acre yield of sugarcane throughout India is still very low Up to 1901-02 it was only 8 tons per acre In recent years, it may be regarded as about 15 tons per acre In any well-run farm yields of 30 tons per acre are common.

In 1934, the Maharashtra Chamber of Commerce held a competition with the object of giving prizes for yileds of 100 tons per acre Over 100 tons were actually obtained by three competing farms, by very high manuring and liberal watering

The maximum yield believed to be possible theoretically is 157 tons of millable cane and this has been approached in Hawaii with a yield of 142 tons

As against the present normal production capacity of existing units of 1,084,000 tons, the largest for increased production is likely to be 1,850,000 tons The gap between the present production and the new target is likely to be bridged by expansion of existing factories, installation of new one, the development of sugarcane and the provision of better facilities for factories to secure cane (Dutt, 1946).

CONCLUSION

Progress is possible in (1) the spread of improved canes over the whole sugarcane area, (2) the selection of varieties resistant to pests and disease and (3) the substitution of varieies that are still better in performance than the good ones now in use, specially those, which for a given addition of mineral nutrients give a larger amount of sugar Nitrogen manuring every year is a necessity for sugarcane throughout India.

The problem facing the industry are (1) that the cultivation of sugarcane must be developed on scientific lines to ensure maximum yield at minimum cost, (2) that the efficiency of manufacture, which has already increased during the last decade has still to be improved by co-operative efforts of the industrialists and technicians, and (3) that a definite fiscal policy (sugar continues to be a protected industry, from April, 1, 1947, as recommended by the Tariff Board set up by the Government of India in 1945) should be laid down by the Government once for all.*

* The writer desire to express his thanks to the various authors, from whose papers the materials for the article has been obtained and in particular to Mr N. L. Dutt, for having kindly revised the manuscript and to Prof. M. N. Saha, F.R.S, for his constructive suggestions.

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CENTROSOMES IN YEASTS

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DURING the past two years the cytology of yeasts has attracted considerable attention But the increased interest, instead of clarifying issues, has resulted in some confusion. Any description of the centrosomes in yeasts therefore necessitates a critical analysis of the various structures claimed as centrioles as well as chromosomes

In the year 1906 Fuhrmann[1] described in *Saccharomyces ellipsoideus*, a spindle, the poles of which appeared darkly coloured. He saw occasionally a small body occupying the spindle poles, and speaks with considerable reserve regarding its identification as a centrosome Swellengrebel[2] appears to have seen a similar body, but he is also guarded in his identification. Renaud[3] described a centriole with what appears to be a centrosphere. This centriole is said to divide when the nuclear membrane begins to fade and while the one destined to remain in the mother cell loses its staining capacity, the other has been shown to migrate to the bud A spindle as well as the various mitotic phases are all described even though the author was not able to count the number of chromosomes

A peculiar method of division of the nucleus has been claimed recently in yeasts[4] It is stated that the "nuclear vacuole puts out a slender tube which forms a small protuberance on the cell wall and as the bud grows an enlargement in the end of the vacuolar tube produces the bud vacuole" (pp. 778-779). Thus, it appears to be a division of the nucleus without the disappearance of the nuclear membrane. All the same, certain bodies are identified inside the so called nuclear vacuole as chromosomes without either the demonstration of an anaphase[5] or a positive Feulgen reaction[6]. Further, certain Feulgen positive bodies which also appear to

stain with aceto-orcein are identified as centrioles, but these have neither asters nor a spindle[7] between them. Thus according to Lindegren, the nucleolus of Wager ant Peniston[8], and Janssens and LeBlanc[9] and the nucleus of Guilliermond[10] is really the centriole.

The above identification of particular organelles in the yeast cell appears to be based on the belief that "chromosomes are structures which perform a specific biological function rather than specific chemical compounds" and that "the general rules concerning the specificity of the Feulgen stain for chromosomes do not hold in yeasts" (p 774) He admits[11], however, that it "may be difficult to accept the view that the conventional chromatin in yeasts is present in the centriole rather than in the chromosomes, while the chromosomes are composed of volutin or metachromatin" (pp 138-139) The morphological evidence presented is rather inconclusive Darlington defines[5] a nucleus as "a cell body which arises or reproduces by mitosis" (p. 51) while, mitosis is defined as "the separation of identical halves of the split chromosomes into two identical groups from which two daughter nuclei are reconstituted" (p 22) The crucial evidence for any claim of mitosis is, therefore, the demonstration of the anaphase which is lacking in the author's descriptions The observations presented by Lindegren are based on staining with methylene blue, aniline blue in lacto-phenol and toluidin blue It is generally admitted that the nuclei usually do not stain with any of the vital stains[12] (p 338) Further, Ludford[13] has shown that mitochondria especially in cells of tissue cultures not only stain with methylene blue, but also with toluidin blue and brilliant cresyl blue as well This staining can even be fixed temporarily by the iodine vapour method of Lewis Mitochondria[14] like volution contain ribonucleoproteins and since the so-called chromosomes described by Lindegren[11] are said to be composed of "volutin or metachromatin" their identification as chromosomes appears to be of doubtful validity. A careful perusal of his illustrations, especially his *figs. 11 and 21* would show that the variability in size and shape of the bodies figured is more in consonance with the behaviour of mitochondria during phases of cellular synthesis than of chromosomes during cell division. Jeener and Brachet[15] state that it appears to be definitely established that the affinity of yeast cells for basic dyes, especially toluidin blue, is mainly due (*i*) to the presence of very great quantities of ribonucleic acid in the cytoplasm (3 per cent by moist weight) and (*ii*) to the relatively small quantity of thymo-nucleic acid (0·3 per cent by moist weight) in the minute nuclei of yeasts. Van Herwerden[16] had demonstrated that yeasts deprived of phosphate do not show any affinity for basic vital dyes. If yeast chromosomes are really composed of volutin or metachromatin as claimed by Lindegren, then, it logically follows that dividing cells in phosphate free media would show only Feulgen positive centrioles, but no chromosomes.

Since according to the technique given elsewhere[17, 18] cultures could be obtained without any visible vacuole in the cells and since Cassaigne[19] has already demonstrated that vacuoles often originate *de novo* in yeasts, the nuclear vacuole can only be the vacuole described by Guilliermond In 1899 Mathews[20] described the vibrations of the ergastoplasmic fibrillae in the pancreas cells when treated with mercuric chloride and explained it as due to osmosis When one realizes that part of the "ergastoplasm" of the earlier workers turned out to be the badly fixed mitochondria[21], it would be apparent how the description of vibration of the so-called chromosomes in the nuclear sap by Lindegren would appear intelligible. The small bodies in the so called nuclear vacuole whose activity is said to be "strongly reminiscent of a flock of midges hanging in the summer air" (p. 774) are in all probability the metachromatic corpuscles described by Guilliermond[22] (p 129).

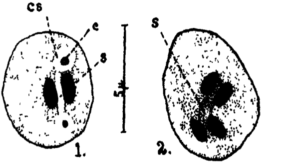
Thus having shown that the criteria for identification employed by Lindegren are unsatisfactory, let us now turn to his identification of certain structures as centrioles. Just as in the case of the chromosome, continuity of the centrosome is inferred from the regular presence of the components of the central apparatus, the basal granules occurring in association with the cilia and flagella[23] The artificial production of cytasters by Morgan[24] and McClendon[25] led Wilson[7] to conclude even in 1904 that the possibility of the centrosomes arising *de novo* has always to be kept in view The claim that the centrosome forms the dynamic centre of the cell by van Beneden and Boveri was based on its role in the formation of the amphiaster. "These investigators agreed that the amphiaster is formed under the influence of the centrosome, which by its division creates two new 'centres of attraction' about which the astral systems arise and which form the loci of the entire dividing system" "In them are centred the fibrillae of the astral system, toward them the daughter chromosomes proceed, and within their respective spheres of influence are formed the resulting daughter cells" (p 75). One expected an identification of a centriole based on the above criteria. The validity of the identification of particular structures in a dividing yeast cell as centrioles which neither have asters nor a spindle between them can just be imagined.

Belonging to an entirely different category are the identifications of chromosomes and centrioles presented in two recent publications by Mohanbabu and Bakshi[26, 27]. The use of toluidin blue as a re-

gressive chromatin stain is nothing new[12] (p. 188) but what is more surprising is the result presented by the above authors. Some observations on the cytology of the control and giant strains of *Torulopsis utilis* were recently published by Thomas[28] who stated that while only two Feulgen positive bodies are present in both the strains, those in the major strain were greater in size. The strain investigated by Mohanbabu and Bakshi[26] seems to be one of those studied by Thomas since it was originally obtained from Dr Thaysen. Unaware of the publication of Thomas these authors claim to have observed four chromosmes in *T. utilis*. Acceptance of their claim is therefore dependent on demonstration of a positive Feulgen reaction. What is more surprising is the criterion on which two centrioles are identified in *T. utilis*. The reasons appear to be that (*i*) they only stain lightly with toluidin blue, (*ii*) that they are aloof from the chromosomes and occupy the poles of the budding cell and (*iii*) since the sizes of the chromosomes are genetically controlled the extra bodies ought to be the centrioles. It would be admitted that the above are not criteria for the identification of centrosomes.

In the second contribution they[27] arrive at the conclusion that there are 12 chromosomes in an actively dividing cell of *S. cerevisiae*. Their description is rather confused and it appears likely that the diploid number may be six as evidenced by the anaphase illustrated by them in *Fig. 3*. Since they seem to have had no success with the Feulgen technique their results require confirmation. In *S. cerevisiae* also they claim to have seen two centrioles without any demonstration of a spindle.

Very recently we have been able to locate the centrioles with centrospheres in some cells fixed in Carnoy-ironhaematoxylin preparations. When even in higher animals the demonstration of a centrosome in all cells and at all stages is said to be an impossibility, the difficulty of demonstration in yeasts can just be imagined. Fig. 1 is an early metaphase stage from the brewery strain *Sc. 9* (N.C.T.C. 3,007) showing the two chromosomes with a developing spindle (s). At the poles of the spindle could be seen the centrioles (c) surrounded by a clear area representing the centrosphere (c.s.). The centrioles present the structure shown in Fig. 1 and appear lightly glistening. In the anaphase stage shown in Fig. 2 the spindle is clear but neither asters nor centrioles could be seen. A single centrosome could however be seen in early prophase stages. Disappearance of the centrosomes in anaphase is not surprising since Belar[29] observed a similar phenomenon in *Monocystis* and Yamanouchi[30] in *Polysiphonia*. However, it appears quite likely that with improvements in technique it may be possible to demonstrate the centrosome during the various phases of mitosis.



The organization and proper functioning of the spindle is said to depend not only on the centrosomes but also on the centromeres[31]. Polyploidizing agents[31] are said to inactivate the centrosomes and centromeres and since by treatment of the above strain with acenaphthene we have been able to produce a tetraploid[32], the validity of our identification does not arise at all.

The yeast cell is unique in that it can either grow or ferment. Naturally, its physiology should be different when growing either aerobically or anaerobically. Much of the confusion regarding the structure of the yeast cell could be traced to a lack of appreciation of the importance of the above physiological difference. Investigations of the nuclear behaviour during aerobic growth should precede any attempt to correlate the behaviour of the nucleus under varying physiological conditions. Strictly speaking, only the phenomena of division of the nucleus during the aerobic phase is comparable to the division of the nucleus in higher animals and plants. It appears to us that much of the confusion in the field would automatically disappear if cytological behaviour is investigated under almost identical physiological conditions.*

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* We are very grateful to Sir J. C. Ghosh, Kt., F.N.I. and Mr M. Sreenivasaya for their encouragement and to the Council of Scientific and Industrial Research for generous financial assistance.

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Notes and News

GOVERNMENT GRANT TO THE INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

WE are glad to learn that the Government of India have been pleased to sanction a non-recurring grant of Rs. 3,10,000 and a recurring grant of Rs. 1,59,000 for 1947-48 and similar grants of Rs. 1,22,000 and Rs 2,46,700 for 1948-49, towards reorganization and expansion of the Indian Association for the Cultivation of Science, Calcutta The Government have also sanctioned an interest-free loan of Rs 5 lakhs to enable the Association to acquire new land, and construct more commodious buildings for its increased activity.

Founded in 1876 by the late Dr Mahendralal Sircar, the Indian Association for the Cultivation of Science is one of the oldest non-official scientific research institutes and has an unparalled tradition of research in the physical sciences for the last seventy years The present widespread interest in sciences and scientific research has its origin largely in the pioneering efforts of the Association under the able leadership of such nineteenth century doyens of science as Dr Mahendralal Sircar, the founder secretary, Father Lafont of the St. Xavier College, Sir J C. Bose, Sir Asutosh Mookherjee and Sir P C Ray Early in the present century, the Association developed into a great centre of physical research in India under Sir C. V. Raman, whose pioneering researches in acoustics, optics, and scattering and dispersion of light were all conducted in its unassuming laboratories. The famous optical effect now associaed with his name was discovered in the laboratory of the Association in 1928. After Sir C. V. Raman, Prof. (now Sir) K. S. Krishnan, as Mahendralal Sircar Professor of Physics, carried out a series of brilliant researches in the field of crystal magnetism, in recognition of which he was elected in 1940 to the Fellowship of the Royal Society of London The present Mahendralal Sircar Professor, Dr K. Banerjee, a noted worker in crystallography and structure of matter, has already built up an active research school in his field of investigation and has ably maintained the Association's long tradition of research.

While the war was in progress, the members of the Managing Board realized the supreme need for expanding the activities of the Association in order that it can play a more important and effective role in the post-war scientific life of the country In view of the growing importance of fundamental research in physics and chemistry of high polymers, the Board prepered a bold plan of reorganization and development This would not only strengthen the present fundamental researches in X-rays, Optics, Raman effect, and magnetism, but also encourage researches in the chemistry and physics of the high poymers, which, next to researches in nuclear physics, is probably the most active and fruitful field of research at the present times

The plan contemplates the establishment of six professorships in Chemical Physics, Physical Chemistry, Organic Chemistry, Inorganic Chemistry, X-ray and Optics. Besides these six professors, the research staff will consist of six scientific officers, six senior and twelve junior scholars. It has further provided for five laboratory technicians and five assistants, a good workshop and a well-equipped library.

As the present buildings and land are quite inadequate for the expansion thus contemplated, the plan has proposed acquisition of new land in the subarban area to the extent of nearly 40 *bighas*, and construction of a new building, commodious enough to house the different laboratories, library, and work-

shop. The capital expenditure, involving land, buildings, electrical, gas and water connections, laboratory equipment and workshop, has been estimated at Rs. 13,32,000 and the recurring annual expenditure at Rs 2,87,700.

The nearest parallel to the Indian Association for Cultivation of Research is the Royal Institute of Science, London Both are small institutes, founded by private persons, and having the barest minimum of administrative machinery. The professors have been allowed complete freedom in choosing their lines of research We hope these feature will be retained under the new organization The public has also to be reminded that the Founder Secretary made great sacrifices to raise the necessary funds. The present endowment of nearly seven lakhs of rupees, on the interest of which the Association has run for nearly 70 years, was raised through his efforts, mainly from amongst persons who were benefited by his medical skill For example, he cured the Maharajah of Vizianagram of some painful disease, and instead of accepting a large fee running into nearly five figures, asked the Maharajah to give a suitable endowment to his pet Association It is regrettable that after his death, no great benefactor has come forward to help the Association with large grants and endowments except the late Rai Bahadur Behari Lal Mitra, and the Government of India. If the Association is to fulfil its new obligations, it is obvious that they must raise more endowments, and secure larger permanent grants We hope the generous public will contribute generally to appeal for funds which, we understand, will be issued by the authorities of the I A C. S

The Government approval of the scheme of research at the Indian Association and their generous grant, including the loan, for the next two years are a fitting recognition of the very important part scientific research is destined to play in the future development of the country We understand that the negotiations for land are almost complete and work on the construction of buildings will start soon. We hope to see the Association in full operation in its new home before long and wish it a brilliant record of researches and new discoveries which will dwarf its past achievements however great.

INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS

THE General Assembly of the International Union of Pure and Applied Physics was held in Paris on January 3 and 4 in the Salle du Conseil de la Faculté des Sciences at the Sorbonne, and was attended by 30 to 40 delegates. The various subjects discussed during the 2-days session of the Assembly include the future relationship of the International Council of Scientific Unions with the UNESCO, the general policy of the Union of Physics, the need for the formation of Commissions and groups under the Union, budget, and the election of office-bearers and representatives on the Commissions

M. M Establier and Yeh Chu-Pei reported on the recent agreement between the ICSU and the UNESCO, which establishes mutual recognition between the two bodies The agreement lays down that to maintain mutual relationship, each of the two bodies will send an observer to all meetings of the other or its Executive Committee and that representatives of ICSU or of individual unions may be invited to serve on Advisory Committee set up by the UNESCO General Conference The Assembly welcomed the conclusion of the agreement, as a step of great value for the future work of the Union.

In his report to the Assembly, the General Secretary, Prof. P P Ewald, discussed the future policy of the Union He emphasized the necessity of organizing National Committees of Physics as an immediate step, as without such Committees the work of co-ordination became extremely difficult He deplored that so far only a few adhering countries had organized NCP and requested the delegates to see to it that such committees were organized without delay in those countries which had not already done so.

The General Secretary referred to the recent formation of the *Union of Pure and Applied Mechanics*, at a conference on this subject held in Paris in September, 1946, and also of the *Union of Crystallography*, at a conference in London in July, 1946, for both of which preparatory committees were formed to work out the draft statutes

On the necessity of forming the Union's own Commissions, the Secretary held that, for active work, it was not sufficient to send representatives on Joint Commissions sponsored by the ICSU at the request of other Unions. He emphasized that the Union must develop its own Commissions, and welcomed the recent formation of the Optical Group, due to the initiative of Professor Fleury of France, within the Union.

Professor Ewald also made a number of important suggestions by way of future projects. He proposed the preparation of a Directory of Physical Laboratories and a Directory of Physicists. He further suggested that the Union should collect documentary evidence of great living physicists and of events of importance such as the sound films on Fabry and Langevin, in which events of their life and research activities were recorded, and should bring into existence a Physics Archives for this purpose. He also thought that a Handbook of Physics, containing the recent progress in physics

in different countries, was a great necessity, and the Union should seriously consider undertaking of such work. Finally, he maintained that the guiding principles of the Union should be to see that the Union remains a strictly scientific institution and international in character and that it watches over the dignity of scientists.

At the concluding session, the following Commissions of the Union of Physics were set up (1) Cosmic Rays, (2) Unit of Radio-activity, (3) Symbols, Units and Nomenclature; (4) Thermochemistry, and (5) Optics Representatives to the following Joint Commissions were elected (1) Physico-chemical Data, (2) Viscosity, (3) Ionosphere, and (4) Radiometeorology Following is the list of office-bearers for 1947-48 *President* H. A Kramers (Leiden), *Vice-Presidents* Cz Bialobrzeski (Warsaw), K K. Darrow (New York), Sir Charles Darwin (London), P P. Ewald (Belfast), C J Gorter (Leiden), J C Jacobsen (Kopenhagen), and P. Scherrer (Zurich), *General Secretary* P. Fleury (Institut d'Optique, 3 bd Pasteur, Paris XV); *Honorary Treasurer* A Perard, *Finance Committee* —Ed. Bauer, C J Gorter

SOVIET SCIENTISTS SUGGEST TWO MAGNETIC POLES

At the All-Union Conference of Geographers which recently concluded its seven-days session, the Soviet geographer M Ostrekin presented an exciting paper on the possibility of two magnetic poles in the Arctic (*Moscow News*, February 5, 1947). In 1941, as a member of the Arctic Expedition to the Pole of Inaccessibility led by the well known Arctic flyer Ivan Cherevichny, Ostrekin had an opportunity of making magnetic observations at the various points where the plane landed on the ice In his present paper based on these observations, he has concluded that the existence of two poles in the Arctic is no more a speculation, but a certainty. In his discussion, he referred to the reported anomalous deviation of the compass needle when, in May 1945, a British Lancaster aircraft flew over the area of the Sverdrup Islands. The swing of the compass needle was as great as 89°. The British scientists, however, interpreted this anomalous deviation as due to the fact that probably the magnetic north pole was situated somewhere on the Sverdrup Islands and not where it was previously supposed to exist. The Soviet scientists, on the other hand, are inclined to believe that the British explanation is erroneous and that the significant observation of the British Lancaster can be looked upon as another confirmation of the existence of two magnetic poles in the Northern Hemisphere.

The theory of two magnetic poles in the Arctic has a history. Since the discovery of the magnetic pole on Boothia Peninsula in Canada by James Clark Ross, during the expedition of 1829-33, this was supposed to be the only magnetic pole on the Northern Hemisphere In 1905-06, Amundsen established that this magnetic north pole lies at 69° 18′N lat and 96° 27′ W long, more than 2,000 km. from the geographical north pole. In 1937, Professor B Weinberg, a Soviet scientist, advanced the bold hypothesis of two magnetic north poles from a study of existing data on magnetic declination Shortly after, the Soviet Drifting North Pole Station and ice breaker Sedov expedition made magnetic observations in the Arctic and their findings were studied and analyzed by Professor Weinberg in 1940. He was led to his previous conclusion, and further made the definite suggestion that the second magnetic north pole should be somewhere in the Sedov region. He even called it Sedov-Pole

The findings of the Soviet scientists are no doubt of great importance But in view of the danger that, in discoveries of this nature, the scientific aspect is often liable to be surpassed by the enthusiasm of national claims, it appears desirable that this should form the subject of further study and investigations by an international body of experts The International Council of Scientific Union, through a suitable Commission or individual Union, is best suited for organizing polar expeditions to settle this question once for all, and we shall be glad to see such an endeavour materialize in the near future

PLAN FOR A NEW UNIVERSITY FOR GUJARAT

We have just to hand the plan for the proposed new University of Gujarat, drawn up by the Gujarat Vishva-Vidyalaya Mandal The present scheme owes its origin to the desire of the people of Gujarat to have a university of their own to cater to the growing needs of higher education in that part which includes the British districts of Ahmedabad, Kaira, Broach, Panchmahals and Surat and the Indian States of Baroda, Palanpur, Kathiawar and Cutch For some time past the inadequacy of the Bombay University to satisfactorily meet the demands of higher education of the entire Province was being acutely felt, and there were insistent proposals for creating more universities in Bombay In 1926, the Setalvad Committee, for instance, recommended the establishment of regional universities in the Province of Bombay, one each for Maharastra, Gujarat, Karnatak and Sind

Gujarat, with 10 colleges for Arts, 8 for Science, 3 for Commerce, 2 for Law, 1 for Teachers' Training, 6 centres for Postgraduate teaching and 4 research centres—at present all affiliated to the Bombay University, undoubtedly presents a clear case for a

separate regional university In 1943, the Gujarati Library Conference adopted a resolution proposing the establishment of a University of Gujarat In 1944, the Executive Committee of the Gujarat Vernacular Society appointed an expert committee, the Gujarat Vishva-Vidyalaya Mandal (the Gujarat University Committee), to work out the details of the scheme of the proposed university.

The scheme recommends, among others, Ahmedabad as the seat of the Gujarat University, Gujarati as the medium of instruction and administration in the University and Gujarati, Hindustani and English as compulsory languages to be taught. The subjects of instruction recommended include Arts, Commerce and Economics, Science, Technology (with Engineering), Law, Agriculture, Medicine, Fine Arts and Education, for each of which a separate Faculty has been proposed The total student population of the University has been estimated at 1000

The scheme involves a capital expenditure of about Rs 1 crore and a recurring expenditure of over Rs 20 65 lakhs The capital expenditure includes administrative buildings, central hall, library and museums, hostels and the buildings and equipments of the various Faculties The annual income from tuition and examination fees is expected to amount to Rs 5 5 lakhs The Committee expects the Government to come forward with a substantial block and recurring grant to enable the establishment of the University and hopes that the people of Gujarat will also generally contribute to the University fund. We are fully in agreement with the scheme and hope that the Government of Bombay and the industrialists and moneyed gentry of Gujarat will co-operate in jointly undertaking the financial responsibility and thus contributing to the early materialization of the University.

COAL CONSUMERS ASSOCIATION

EXAMINATION of the Coalfields' Committee Report from the point of view of industrial consumers of coal was the subject of the presidential address given by Mr D. C. Driver at the first annual general meeting of the Coal Consumers Association of India, held on 24th January last at Calcutta

Mr Driver said that, in the present political mist of uncertainty, producers of coal were holding up their extensions programme because they did not know how soon the policy of nationalizing coal mines would be operative.

He further stressed the suggestion made by the Indian Coalfields Committee that the time was ripe to consider the establishment of Wire Rope Industry in India as they would be required in large quantities for the aerial ropeways to be constructed in the collieries in the near future. In another suggestion, Mr Driver requested the Government to appoint an expert committee of engineers to examine how far mining equipment, both basic and ancillary and mining stores, can be manufactured in India Mr Driver further urged the necessity for demarcating a separate industrial area, comprising the coalfields of Jharia and Raniganj, the iron and steel and other basic industries, and power schemes of national importance in the adjoining areas, that could be better governed by a board of expert engineers under a separate administration directly responsible to the centre The proposed change in the administration would prepare the ground for later nationalization should this become a practical proposition.

BIOLOGIA

WE have much pleasure in announcing the establishment of a monthly newsletter supplement to *Chronica Botanica*, the first two issues of which entitled *Biologia* (January and February, 1947) have been received by us *Biologia* has been established at the request of numerous biologists from many countries, and we hope that it will fill the need for newsletter reporting quickly on developments of a professional and international interest and have good influence on the co-ordination of workers in the various branches of the pure and applied plant and animal sciences throughout the world. *Biologia* will be kept small and informal Subscription to *Biologia* has been fixed at $4 00 for 2 years

VARIATION IN LOCUSTS

'EVOLUTION and Practical aspects of Variation in locusts' was the subject of a special lecture given by Dr M L Roonwal, of the Zoological Survey of India, before the Zoological Society of Bengal at Calcutta on February 3, last.

While the majority of the short-horned grasshoppers (*Orthoptera*) are non-swarming, a few species (less than a dozen) periodically swarm in enormous numbers They are of the highest agricultural importance, as causing enormous depredations during swarming years. The Desert Locust, *Schistocerca gregaria* (occurring in India), exists in two morphologically and physiologically distinct phases—the swarming or *gregaria* phase and the non-swarming or *solitaria* phase. The chief factor in producing phase-differences appears to be the degree of muscular activity induced in nature, through increased or decreased population density. The *solitaria* form is further polymorphic, there

being 6-, 7-, 8-eye-striped individuals; the *gregaria* phase on the other hand have 6-eye-striped individuals. This variability has been utilized to predict swarming. From the evolutionary point of view, this variability is significant in that it is connected with periodic population-fluctuation. Variation is lowest in high populations and greatest in low populations. Here, therefore, we have a clear example of the Wright-Dubinin effect of random "drift" of gene frequencies in small, partially isolated population, leading to speciation, provided suitable isolation could be achieved.

FOREST RESEARCH IN INDIA AND BURMA

THE work of the Forest Research Institute continued to be governed in 1944-45 by war demands, which were necessarily given priority over the normal peace time programme of research. Nevertheless, the extent to which the Institute was able to contribute towards a solution of problems arising from war conditions was due in no small measures to the research done under long-term programmes in the pre-war days, according to a report of the "Forest Research in India and Burma, 1944-45, Part I", published by the Forest Research Institute, Dehra Dun.

The Utilization Branch of the Institute was engaged during this period almost entirely in dealing with research on war problems. A noticeable development was that users of timber were appreciating to a greater extent the necessity of identifying the species so that they could assure themselves that inferior substitutes were not supplied. The value of using seasoned and whenever possible treated timber, if best results were to be obtained under the severe conditions of a tropical climate, was also recognized.

A preliminary survey was made during the year of the plywood industry with a view to assessing the efficiency of different factories engaged in the manufacture of tea chests for export and of the possibility of grading the factories into classes according to the quality of their chests.

A good deal of progress was made in the preliminary investigations of fungi attacking trees in many parts of India and of fungal attack on timber in depots.

The main activities of the Institute on the chemical side continued to be the investigation of sources of important essential oils.

RADAR DETECTS METEOR SHOWERS

RECENTLY, the Central Radio Propagation Laboratory of the National Bureau of Standards, U.S.A., and the Slough Radio Research Station of the D.S.I.R., England, carried out a series of important experiments on the applicability of radar methods to the study of meteor showers and allied problems. For some time past, suggestions were made from different quarters that the highly ionized tracks of gases and vapours formed in the atmosphere by the impact of meteors might be conveniently studied by the radar methods and a permanently useful radar technique developed for the observation of meteor showers. The dates for October 9 to 11, 1946 were selected for the experiments, as the astronomers had already predicted an unusually rich meteor shower on October 9 when the earth was expected to pass through the orbit of the Giacobini-Zinner Comet. The results of observations at both the stations, on two sides of the Atlantic, proved highly successful and fulfilled the expectation that the problem of meteor showers would lend to radar methods.

In the experiments carried out by the Central Radio Propagation Laboratory, and recently reported in *Science*, November 8, 1946, by Bateman, McNish and Pineo, of the National Bureau of Standards, a standard signal corps type SCR-270-D radar was used. It operated at about 107 megacycles, with its antenna oriented at an azimuth of 315° and with a vertical elevation angle of 45°, and produced the main beam which was approximately 40° × 20° in width. The radar transmitter had a peak pulse power of about 100 kilowatts. Visual observations were made on the type A radar oscilloscope, while a PPI presentation oscilloscope, with a rotating time base of period of 2 minutes, was used to obtain photographs of the observed echoes.

On October 9, the rate of radar echoes per hour increased from approximately 8 between 7-30 and 8-30 to a peak of over 60 between 10-30 and 11-30. The predicted time for the maximum intensity of the shower was 10. After 11-15, the rate fell to about 20 per hour. Distances of the ionized layers producing radio echoes were found to range from about 60 miles to 200 miles.

Besides, there were also transient radar echoes usually lasting for a second or less, which is believed to have been caused by the meteors. Unfortunately, owing to clouds, no visible meteors could be observed; but the range of distances and the earlier observations of O.P. Ferrell (*Physical Review*, 69, 32, 1946) who reported coincidences of radar echoes with visible meteors strongly suggest the view that the transcient echoes were due to meteors. This view also appears to be confirmed by the experiments on the night of October 15, in course of which 7 visible meteors and 17 transient radar echoes were observed.

These investigations clearly indicate the future possibilities of radar as a useful technique for meteor

study. Its special advantage is that the method is applicable during day light hours as well as during a cloudy night when the visibility is extremely poor Such studies may also throw much light on the physical structure of ionosphere and on the effect of meteor reflections on radio propagation

INDIAN PHYTOPATHOLOGICAL SOCIETY

THE mycologists and plant pathologists who met at the Indian Agricultural Research Institute, New Delhi, on February 28, 1947, resolved to establish a Society to be known as the Indian Phytopathological Society, membership of which is open to all persons and concerns interested in the study of fungi, bacteria, viruses and their useful (industrial fermentations, food yeast, penicillin) and harmful (plant and animal diseases) aspects The constitution and by-laws that had been drawn up, were approved A Committee consisting of Mr J F Dastur, *Chairman*, Drs S R. Bose, A Sattar, B N Uppal, Dr B B Mundkur as *Secretary-Treasurer (and Convener* to found a Journal), was elected for the year 1947 It was also resolved to designate the members joining before January 10, 1948 as *Charter Members*

NEW FELLOWS OF THE NATIONAL INSTITUTE OF SCIENCES, INDIA

THE following gentlemen have been elected Ordinary Fellows of the Institute in January, 1947

S Basu, M Sc , Senior Meteorological Officer at R.A F. Group Headquarters, Bangalore , Dr U. P Basu, M.Sc , D.Sc , Chief Chemist, Bengal Immunity Co., Ltd , Calcutta , J Coates, A R S M , F G S , Senior Geologist, India, The Burmah Oil Co , Ltd , Digboi , Dr K Ganapathi, D Sc , Assistant Director, Chemotherapy Department, Haffkine Institute, Parel, Bombay ; Dr B. S. Kadam, Ph D., Director, Central Tobacco Research Station, Guntur ; Dr V R. Khanolkar, M.D., Director of Laboratories, Tata Memorial Hospital, Bombay , D. D Kosambi, S.B. (Harvard), Professor of Mathematics, Tata Institute of Fundamental Research, Bombay ; Dr D. R Malhotra, S B (Harvard), Sc D. (Brussels), A.M.I Ch E , A M.I E., Metallurgist, B B C I Railway, Ajmer ; Dr B B. Mundkur, Ph.D (Iowa), Second Mycologist, Indian Agricultural Research Institute, New Delhi , Dr Basudev Narayana, M.Sc , M B , Ph D , F R.S E , Professor of Physiology, Prince of Wales Medical College, Patna , Dr B P Pal, Ph D , F.L S , Economic Botanist and Joint Director, Indian Agricultural Research Institute, New Delhi , Dr V G Panse, Ph.D , Statistician, Cotton Genetics Research Scheme, Institute of Plant Industry, Indore , Dr P B Sarkar, D.Sc. (Dacca), Senior Research Chemist, Indian Central Jute Committee, Calcutta , Dr B N Srivastava, D Sc , Lecturer in Physics, Allahabad University , Dr L C Verman, B.S Eng., M S., Ph D (Cornwall), F Inst.P , Acting Director, Physical Laboratories, Council of Scientific and Industrial Research, Delhi

ANNOUNCEMENT

We have much pleasure in announcing that the Indian Science News Association have received an annual grant of Rs 1,000 for five years from Messrs Burmah Oil Company In making this grant, the Company have expressed their great appreciation of our humble effort at disseminating scientific information and offering a medium for healthy and constructive discussion of the various scientific, economic, social and cultural problems of the country We take this opportunity of expressing our sincere thanks to the Company for their generous grant and kind and encouraging appreciation of our work

SCIENCE IN INDUSTRY

A NEW RADIO-ACTIVE DETECTOR

The Review of Scientific Instruments, October, 1946, reports the development of a portable radio-active detector by the Geophysical Instrument Company of Arlington, Virginia, U S A Simple and light in construction and quick and dependable in action, the new radio-active detector offers distinct advantages over the large and bulky instruments, now in use

The apparatus consists of a Geiger-Muller counter tube encased in a metal protecting housing The casing also contains all the auxiliary amplifying devices, together with the batteries and the high voltage source. Standard miniature radio "B" batteries, with a total voltage of 135 volts, are employed, and an oscillator steps up this to over 1,000 volts, necessary for operating the counter The instrument is further provided with earphones and a short connecting cable Under normal operations, the batteries are reported to last for about one month The instrument proper weighs only 4¾ lbs

Within five minutes of turning of the switch, the detector begins to operate and the observer can count the number of clicks per minute, from which to determine the presence or otherwise of the radio-active ore bodies The apparatus has been described as valuable instrument for testing rock and ore samples, locating radio-active minerals, making quantitative estimations of the concentrations of radio-active substances in the ore, and also for useful laboratory measurements of gamma ray intensities

SILICON CARBIDE RESISTORS

THERE has been in recent years significant developments in the industrial application of non-ohmic resistors, *i e*, resistors which, in violation of the Ohm's Law, can pass a current proportional to the fourth or fifth power of the applied voltage. The non-ohmic resistors are specially important for their uses for protection on transmission lines, in D C induction circuits, in radio, for spark quenching at relay contacts, for voltage regulation, for field control of electrical machines, and for variety of similar uses in electrical engineering. Silicon carbide is one of the few materials which can act as non-ohmic resistors, and has already received wide applications of the nature stated. *The Journal of the Institution of Electrical Engineers*, September, 1946, contains a useful article by F. Ashworth, W. Needham, and R. W Sillars, on the electrical properties and industrial applications of silicon carbide.

From the view point of their electrical behaviour, silicon carbides are electronic semi-conductors, non-ohmic, and have resistivities ranging from 10^6 ohm-cm. or more, for small current densities, to 10 ohm-cm., for large current densities. The resistors for use in industry are generally manufactured by bonding silicon carbide with clay and certain minor constituents The bonding is usually effected by any of the three methods, *e g*, dry pressing using a "dry" mix, extrusion using a plastic mass; and moulding or slip casting using a slurry After bonding, the resistors are subjected to a high temperature in a furnace, maximum permissible temperature, however, depending on the nature of the bonding materials The electrical connections are made by a process known as "schooping", which consists in spraying brass, zinc, or copper over the faces by means of a spray gun and then soldering the leads on to the schooped surface

Gray in colour and refractory in character, silicon carbide resistors are stable and have negative temperature-resistance coefficient. Their other physical characteristics such as tensile strength, compression strength, thermal conductivity, thermal resistivity, etc, are as follows: tensile strength —6,000 lb /in ^{2}; compression strength—15,000-20,000 lb /in ^{2}, bulk density—2·35 g/cm ^{3}; specific heat (20-300C)—0 21 g. Cal./g./deg C; thermal conductivity—0·0034 g cal./cm./sec /deg C; and thermal resistivity—30°C/in./watt./in ^{2}

By virtue of its non-ohmic electrical properties, silicon carbide resistors act as electric safety valve by allowing an unusually high load to discharge itself safely These resistors have been used for the protection of field, contactor, clutch, brake and magnetic coils and also in relays and solenoids. In all these cases, the silicon-carbide resistors reduce the peak voltage to a low and safe value and prevent excessive heat dissipation under normal voltage conditions. They further minimize sparking at opening contacts. This property of spark quenching has been applied with great advantage in telephone relays The incidence of lightning surges which, in the past, often led to serious breakdown of the transmission lines, has now been considerably reduced by the use of silicon-carbide resistors in combination with the spark-gaps. Electronic industry has also offered a vast field of application for such non-ohmic resistors. To mention one important use, silicon carbide resistors have already increased the

life of radio transmitting valves by reducing probable damage resulting from passage of excessive current due to a fault

The application of non-ohmic resistors is a recent development It is probable that a much greater variety of industrial uses of silicon-carbide resistors will be forthcoming in future, as our knowledge about the physical properties of such class of materials, yet imperfectly understood, increases

LACTIC ACID FROM SULPHITE WASTE

A satisfactory solution of the vexed disposal problem of sulphite waste from the paper mills has been recently reported from the University of Wisconsin, where an industrial fellowship was established by the Rhinelander Paper Company for the study of recovery of useful chemicals from sulphite waste by the process of Fermentation (*The Chemical Age*, December 28, 1946). The various chemicals produced include lactic acid and acetic acid, whose recovery from sulphite waste is now reported for the first time. Experiments have so far been confined to the laboratory ; but the results obtained are convincing enough to warrant conclusion when the process is submitted to a large-scale recovery. About 95 per cent recovery by the extractions appears quite possible, and if one ton of pulp is assumed to produce 2,000 gallons of waste liquor, the recovery of lactic acid and acetic acid will clearly amount to 285 lb. and 75 lb. respectively per ton of pulp On this basis, an average mill producing 100 tons of pulp daily in a 300-day year will have no difficulty in recovering about 9 million lbs of lactic acid annually at a cost of about 3.4 cents per lb.

Briefly, the process as worked out in the laboratory is this The acid liquor from the blow-pits is first subjected to steam stripping to remove sulphur dioxide and is subsequently neutralized to a slightly alkaline state with slaked lime. The sulphite precipitate is next filtered off, and carbon dioxide is added to the filtrate till it attains the desired acidity. The liquor is now ready for fermentation. An inoculum of lactic acid producing organism, *Lactobacillus pentosus*, is prepared on a medium preferably composed of malt sprouts and molasses The liquor is then allowed to undergo fermentation at a temperature of 30°C, which requires, for its completion, about 40 to 48 hours Generally, 1·8 per cent of lactic acid is formed, and during the progress of fermentation the acid is neutralized by addition of calcium carbonate or slaked lime.

The recovery of the acid is next effected by first concentrating the fermented liquor from 12·5 per cent solids and 1 8 per cent lactic acid to about 40 per cent solids and 6 per cent lactic acid The acids are then extracted from the waste liquor by suitable solvents which must not at the same time dissolve the impurities. Since the liquor is very viscous at room temperature, it is raised to about 90°C, at which the extractions can be made easily and more successfully The acids are then washed out of the solvents with water and the final solution is concentrated The acid naturally present in the liquor is, however, recovered by distillation The purity of the crude concentrate depends on the nature of solvents used With amyl alcohols, the percentages of acetic acid, impurities and water in the crude concentrate are 90, 8 and 2 respectively The separation of lactric acid from the non-volatile impurities is still an unsolved problem, and work on it is now in progress.

The recovery of lactic acid, among other chemicals, from the sulphite waste is of great importance. At present, most of this waste is discharged into rivers, lakes or some other natural drainages, which has lately raised grave problems of public health It will thus not only yield a valuable by-product, but its commercial utilization will solve the very serious problem of water pollution.

HIGH PRESSURE CHEMICAL REACTIONS AND THEIR TECHNIQUE

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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, DELHI

ONE of the earliest recorded instances of the use of a pressure vessel for effecting a chemical operation is the Papin's Digester invented in 1681 Papin used his digester for the extraction of marrow from bones and he found that at higher pressures a much better extraction was possible The digester consisted of a bronze body and cover secured to the body by means of a saddle clamp and screw, an interesting feature being a safety valve which worked on lever and weight principle. Early chemists employed sealed glass tubes for reactions at moderate pressures In this manner Bunsen prepared cacodyl and Frankland, zinc ethyl For the production of large quantities, Frankland[1] subsequently constructed an autoclave of wrought iron which was capable of standing a pressure of 100 atms The joint between the cover and body was secured by means of a lead washer Later he used a digester made of copper for the preparation of large quantities of zinc ethyl

In the field of chemical industry the use of pressure reactions developed about the middle of the nineteenth century with the discovery of synthetic dyes by W.H Perkin in 1856 This led to rapid development of the technique of large scale pressure chemical reactions and vessels. The requirements of the dye industry for large quantities of dimethylaniline, dimethylamine and other similar bases afforded great impetus to these developments Autoclaves of about 80 gallons capacity and capable of working at pressures of 100 atmospheres were commonly used in this period The dyestuffs industry which developed to a high pitch in Germany and other countries by the end of the last century provided the necessary experience in the development of modern high pressure and high temperature autoclaves. The development of high pressure equipment made possible the famous Haber-Bosch process for the manufacture of ammonia from atmospheric nitrogen

SYNTHESIS OF AMMONIA

The Haber-Bosch process is the first and even today an important chemical reaction using high pressure and high temperature for the large scale manufacture of an industrial product. The Haber process was in fact anticipated by Le Chatelier[2] in 1901, who caused nitrogen and hydrogen to combine under high pressure in contact with a catalyst. These results were confirmed by Perman.[3] Haber and co-workers[4] commenced work in 1904 and studied the equilibrium between nitrogen, hydrogen and ammonia, using different catalysts and variations of pressure and temperature over a very wide range The synthesis of ammonia could be represented by the equation ;

$N_2 + 3H_2 \rightarrow 2NH_3 + 24{,}000$ cals (Haber-Berthelot)

The heat which is developed in the reaction is used to maintain the required temperature of the catalyst. The temperature and pressure relationship is clearly shown in the diagram below by Larsons.[5]

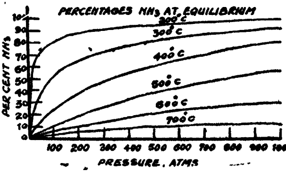

FIG. 1.

The pressures employed in the actual manufacture of synthetic ammonia vary from 100—1000 atms and a reaction temperature of 400—600°C. Even under these conditions the synthesis is only possible with the help of a catalyst which consists essentially of metallic iron[6] The catalytic activity of pure iron rapidly diminishes after a short time while if a small percentage of magnesia or alumina is added the activity is almost permanent The original Haber-Bosch process involved working pressure of 200—250 atms. and reaction temperature of 500—600°C The hydrogen nitrogen mixture was obtained from a mixture of water gas and producer gas Air was burned with coke to give producer gas which was mixed with water gas obtained by the interaction of steam and red hot coke, and the mixture passed with excess of steam over an activated iron oxide catalyst. When suitable quantities of water gas and producer gas are used initially, the resultant gas after removal of CO_2 etc. consists of nitrogen and hydrogen in proportions approximately 1 : 3 and is used after final purification for the synthesis of ammonia. Under the conditions of Haber-Bosch process a theoretical conversion of 13 per cent per catalyst contact is possible and in practice the conversion reaches about 8 per cent.

The first catalyst tubes used in the Haber-Bosch process were of mild steel externally heated, but this design was quickly abandoned on account of the action of hot hydrogen and ammonia on steel walls of such vessels. All recent types of catalyst tubes are constructed of alloy steels, and the tubes are specially designed to prevent the weakening of the shell by gas penetration and corrosion.

The other important high pressure synthetic ammonia processes are the Claude, the Casale and the Mont Cenis. These only differ from the original Haber process in details of the working pressures and temperature. In modern plants hydrogen is obtained by electrolysis of water which is mixed with air in suitable proportion and burnt. The resultant mixture of hydrogen and nitrogen is passed over the catalyst at suitable temperature and pressure

The importance of this process will be realized from the following statistics. In 1913,[7] about 50 per cent of world's nitrogen was supplied from nitrate of soda chiefly from Chile In 1923, the amount obtained from that source decreased to 32 per cent owing to the competition from the synthetic ammonia industry. In the year 1929,[8] the Chilean nitrate supply had dropped to only 23 per cent of the total nitrogen supply. The net cost of Chile nitre had been considerably reduced but that could not check the production of synthetic ammonia which was much cheaper and thus the importance of Chilean nitre industry has been greatly diminished

The technique acquired in the development and operation of these high pressure synthetic ammonia plants has turned the attention of chemists and chemical engineers to other branches of chemical industry where high pressure could profitably be applied. Perhaps the most successful of these are the syntheses of methyl alcohol from CO or CO_2 and H_2; and of urea from CO_2 and NH_3. In the former case the operating conditions require 200—300 atms. and catalyst temperature of 390-425°C In the case of urea, the pressure generally employed is 100 atms. and the temperature is 150°C [9]

Synthesis of Methyl Alcohol and Urea

$$CO + 2H_2 \rightarrow CH_3OH + 27{,}200 \text{ cals}$$

As in the case of ammonia, the production of methyl alcohol is favoured by increased pressure, and by diminishing temperature, the latter of course, to be consistent with a practicable conversion rate. The researches of Audibert[10], Patart[11], and later of Morgan, Taylor and Hedley[12], and Wettburg and Dodge[13] have provided the details of methyl alcohol synthesis. The most successful catalyst appears to be a mixture of basic zinc chromate and zinc oxide. The temperatures normally employed are 390—425°C and pressures 200—300 atms. When the catalyst is active, yields of nearly pure methyl alcohol are obtained.

The growth of synthetic methyl alcohol industry can be clear from the following figures. In 1927 production of synthetic methyl alcohol in U.S.A. was 500,000 gallons, and in 1930 it had risen to 10,000,000 gallons[14]. Figures of production after that date are not available but the bulk of world's production of methyl alcohol is now obtained by this method Even higher alcohols are now being produced by reactions at high pressure Synthetic urea is now available as a fertilizer for such crops as vine, tobacco, tea, etc

Production of Nitric Acid from Ammonia

This process consists in passing gaseous ammonia mixed with air in proportions of 1.9 5 through a converter containing a catalyst made of platinum gauze The catalyst is usually cylindrical in shape, and the cylinder is closed at the lower end by a silica plate. The ammonia air mixture, after passing through a heat exchanger in which it is preheated by the hot oxidized gases, enters the top of the catalyst and passes through the meshes of the platinum gauze which after its initial ignition is heated automatically to incandescence by the reaction and oxidation of ammonia to oxide of nitrogen. The fundamental reaction involved consists in the transformation of ammonia to nitric oxide according to the equation (1). Reactions (2), (3) and (4) represent oxidation of nitric oxide to nitric acid.

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O \quad (1)$$
$$2NO + O_2 \rightarrow 2NO_2 \quad (2)$$
$$2NO_2 + H_2O \rightarrow HNO_3 + HNO_2 \quad (3)$$
$$2HNO_2 + O_2 \rightarrow 2HNO_3 \quad (4)$$

The production of synthetic nitric acid is very cheap as compared to the nitric acid prepared by the distillation of Chilean nitre with sulphuric acid In U.S.A. this is the method commonly used for the production of nitric acid

Hydrogenation of Oils

The hardening of oils is a reaction which has attained considerable industrial importance. From the chemical aspect it consists in the saturation of unsaturated fatty acids with hydrogen. Various vegetable or animal oils such as ground-nut oil, cotton seed oil, linseed oil, or whale oil are used. The catalyst employed is always nickel in the form of wool, turnings or wire. It is activated by anodic oxidation in sodium carbonate solution. The oxidation is followed by washing and, finally, by reduction with hydrogen in the hydrogenation plant itself.

The first stage in the hydrogenating procedure consists in heating the oil to the reaction temperature. Nickel has been shown to be active even at room temperature[15], but moderate activity being at about 80°C. The variation in the observed activity of nickel with temperature shows a maximum at about 170°C[16] The activity of the catalyst is also determined by the solubility of hydrogen in the oil Hardened vegetable oils are produced in very large quantities these days and are used for cooking purposes as a substitute for *ghee* and butter

Ipatieff[17] has stutied the hydrogenation of a very large number of aromatic compounds, phenols, polyhydric phenols, unsaturated aldehydes, ketons, diketones, alcohols, ethers, acids, and esters with great success

Hydrogenation of Coal

On hydrogenation of coal or of certain coal products such as high and low temperature tars, hydrocarbon oils with boiling point depending on the nature of treatment, are obtained In Bergius' early work no outside catalyst was used, but later on it was found that use of hydrated iron oxide increased the yield to a great extent This hydrogenation is quite different from hydrogenation of oils and of aromatic compounds. In this case catalysts of a completely different type namely, oxides and sulphides of iron, cobalt, tin, and molybdenum are employed and these operate in the presence of sulphur and may be rendered more active by a previous treatment with H_2S. Hydrogen pressures of the order of 200 atms or over are usually necessary for satisfactory conversion, the reaction temperature being about 450°C. In most cases coal is powdered and tar (about 40 per cent) is incorporated with it so that a paste is formed, which can be passed continuously through the autoclave. The yield of oil varies with the nature of coal but the average is about 50 per cent on the weight of coal treated. By Bergius'[18] method a Silesian coal containing 26 per cent volatile matter, 6 per cent ash, 4 per cent water was passed through an autoclave at 400-500°C and with hydrogen pressure 100-150 atms at the rate equivalent to 800 gms. of coal per hour per litre of space. Each 100 kg of coal gave the following products :—

Oil boiling below 230°C.	22 kg.
Higher oils	17 kg
Pitch	16 kg
Gas	15 kg.
Water	10 kg
Ammonia	5 kg
Ash	6 kg.
Unchanged coal	15 kg.

In another case coal mixed with 40 per cent of tar was passed through the apparatus at 450-480°C under a hydrogen pressure of 150 atms Each ton of coal yielded :—

Oil	445 kg.
Residual coal substances	350 kg

Residual substance on retreating gave 80 kg more of oil The total oil thus obtained yielded on distillation the following fractions —

Oil boiling below 230°C	150 kg
Diesel oil	200 kg
Lubricants	60 kg.
Fuel oil	80 kg

Details of typical hydrogenation of lignite have been given by E Laszlo[19] Hlavica[20] has examined the activity of a very large number of catalysts and found that chlorides or oxides of zinc, nickel, cobalt and copper are most effective Iron[21] as sulphide was found to have the greatest catalytic effect of the naturally occurring substances Ormandy[22] has reviewed the Bergius' process in detail By continued research in this field it is now possible to convert more than 60 per cent of coal into petrol[23] The cost of synthetic petrol produced in Billingham Imperial Chemical Industries was about 7*d* a gallon in 1930

It is clear that hydrogenation of coal forms a contribution, the importance of which, from a national standpoint, is difficult to overestimate, for the independence in oil of countries which are deficient in petroleum deposits

Hydrogenation of Crude Oil

The first large scale plant for the hydrogenation of crude oil was erected in 1929 at Bayway, U S.A. by the Standard Oil Company in co-operation with I G Farbenindustries[24] In this process hydrogen was made by heating hydrocarbons with steam and pressure employed was about 200 atms and the temperature 400-500°C.

The following are stated to be the five principal adaptations of hydrogenation as far as oil industry is concerned

1. Conversion of heavy high sulphur asphaltic crude oils and refining residues into gasoline.
2. The alteration of low grade lubricating distillates to obtain high yields of lubricating oil of premium quality.
3. Conversion of inferior burning oil distillates and light gas oils into high gravity, low sulphur, water white oil of excellent burning characteristics.

4. The desulphuration and colour and gum stabilization of high sulphur, badly gumming, cracked naphthas without marked alteration of distillation range
5. Conversion of paraffinic gas oils into low sulphur, gum and colour stable, good anti-knock gasoline.

Apart from hydrogenation, pressure is being increasingly employed in the petroleum industry in the cracking of heavy petroleum oils to produce gasoline fractions The average temperature employed is 900°F and the pressure 700-1500 lbs per sq. inch. The principle of cracking is to convert a petroleum body of a given gravity into other hydrocarbon bodies, some of which are of less and others of greater gravity than the parent stock. The lighter fractions thus obtained are in great demand due to their need for internal combustion engines. The subject has, therefore, gained enormous impetus, and now large proportions of the supplies of high grade petroleum are obtained in this manner

Artificial Rubber

Lately great interest has been shown in the study of the influence of very high pressures on the polymerization of conjugated di-olefines since pressure causes a great decrease in volume, and it aids polymerization Conant and Tongberg[25] used pressures upto 1800 atms for the polymerization of isoprene, and found that 10 per cent was polymerized in 20 minutes at 23°C while after 3 hours 76 per cent was polymerized. The results obtained, however, varied considerably in successive batches. The high pressure polymer resembled vulcanized rubber in being both insoluble and nonplastic Starkweather[26] found that chloroprene polymerized eight times as fast at 6000 atms as at 3000 atms

There has been an enormous work undertaken on high pressure polymerization of ethylene. The main objective was to convert it into suitable fuels, though from this work an outstanding commercial material with rubber-like properties emerged This is the solid polymerized ethylene obtained by the Imperial Chemical Industries known as polythene[27]. It is prepared by heating ethylene at 100-300°C under a pressure of at least 1200 atmospheres when solid or semi-solid polymers are produced. Interesting resinous substances have also been obtained by polymerization of isobutylene at 300 atms. and 100°C.[28]

Production of butadiene by direct union of ethylene and acetylene at 50 atm. pressure and 400-500°C temperature by passing in tubes containing alkali oxides or in tubes lined with lime, silicon, lead etc. has been successfully effected. Ethylene and hydrocarbons heated to 800-1200°F and at 1000 lbs. pressure lead to the production of butadiene and many other bye-products. At present the estimated production of butadiene is more than 100,000 tons a year[29]. This production is a part of synthetic rubber programme Germany depended very largely on the synthetic products for its rubber requirements during this war

The latest development of high pressure catalysts is the production of liquid fuel from a mixture of CO and H_2 commonly entitled the Fischer-Tropson process Iron, cobalt and ruthenium are used as a catalysts A mixture of cobalt-thoria-kieselguhr[30] is also being tried as catalyst Investigations are being carried out for the synthesis of higher alcohol from mixtures of CO monoxide and hydrogen by varying the gas mixture, temperatures, pressures and notably the catalysts

These examples taken from a great number now available, show the great importance of the role played by high pressure processes in modern industry.

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MEDICINE AND PUBLIC HEALTH

CONTINUOUS PARENTERAL ADMINISTRATION OF PENICILLIN

IN *Science*, June 28, 1946, Baxter G Noble, of the Good Samaritan Hospital, Lebanon, Pennsylvania, has described a new method for continuous parenteral administration of penicillin. The method eliminates the disadvantage of repeated and often uncomfortable injections of penicillin, necessary for rapid systematic elimination, and can be applied with advantage in the case of other drugs as well

The method consists in slowly inflating a rubber finger cot introduced into the syringe, by means of gas generated artificially in an electrolytic cell and thus driving the injectible liquid out of the syringe It will be best understood with reference to the following diagramme originally appearing in *Science*

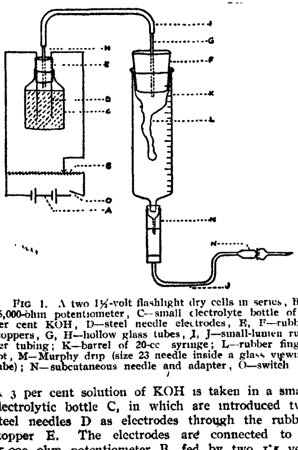

FIG 1. A two 1½-volt flashlight dry cells in series, B—25,000-ohm potentiometer, C—small electrolyte bottle of 3 per cent KOH, D—steel needle electrodes, E, F—rubber stoppers, G, H—hollow glass tubes, I, J—small-lumen rubber tubing; K—barrel of 20-cc syringe; L—rubber finger cot, M—Murphy drip (size 23 needle inside a glass viewing tube); N—subcutaneous needle and adapter, O—switch

A 3 per cent solution of KOH is taken in a small electrolytic bottle C, in which are introduced two steel needles D as electrodes through the rubber stopper E. The electrodes are connected to a 25,000 ohm potentiometer B, fed by two 1·5 volt flash light dry cells A in series. K is the barrel of a 20 c.c. syringe which is fitted with a rubber finger cot L and a stopper F; the finger cot of the syringe is connected with the electrolytic cell C through the rubber stoppers E and F and the connecting small-lumen rubber tubing I The gas generated as a result of electrolysis thus slowly inflates the rubber cot and forces the contents of the syringe, through the Murphy drip M, into the needle. An inlying, deep subcutaneous needle, which can be strapped directly to the leg or to an arm board, is used. The rate of injections can be accurately controlled by the potentiometer and can be varied, as the author states, from 1 c c per minute to 1 c c per hour It is suggested that, for uniform injection, the elevation of the syringe should preferably be at least two feet above the level of the patient

Patients undergoing continuous injection by this method have seldom complained of any discomfort Pronounced local irritation was reported in one case, following too rapid injection The rate of injections, however, should be slow enough for absorption to occur almost immediately, with minimum subcutaneous collection of fluid.

EFFECT OF WHOLE-WHEAT AND WHITE BREAD ON PNEUMOCOCCAL INFECTION

IT is now generally held that, when known essentials are present in equal amounts, a cruder foodstuff is preferable to a refined one. Recent experiments and findings have occasioned some doubts as to the validity of such an assumption G H Hitchings and E A Falco have shown (*Proc. Soc Exp Biol Med*, *61*, 54, 1946) that mice maintained on a synthetic diet are more resistant to SV-1 strain pneumococcus than those kept on usual laboratory diet It was further observed that the susceptibility of mice to pneumococcal infection increased, when certain crude foodstuffs were added to the synthetic diets, and further that the extracts of these foods actually stimulated the rate of growth of the pneumococcus *in vitro*. These experiments led the authors to suggest that the cruder diet probably contained some factor or factors which increased the rate of multiplication of the pneumococcus *in vivo*.

Recently, the same authors reported in *Science*, December 13, 1946, their results of experiments of the effect of whole-wheat and white flour on the progress of pneumococcal infection on mice. It was experimentally observed previously that extracts of whole-wheat flour were more capable of stimulating the growth of pneumococcus *in vitro* than white flour. Accordingly, it was expected that mice main-

tained with whole-wheat bread would be more susceptible to pneumococcal infection than those living on white variety. The authors first selected two batches of mice maintained either on white or whole-wheat bread for six days and then injected the two groups with pneumococcus type I strain (10^{-4} or 10^{-6} ml of a 17-hour culture) The results are reproduced in the table

Thus, whereas only 1 of 49 mice, *i.e.*, 2 per cent, maintained on the whole-wheat diet, survived the infection, 20 of the 50 mice, *i.e.*, 40 per cent, maintained on white bread, survived six days These equipments throw considerable light on the dietary treatment of pneumonia, more such observations are needed to arrive at definite conclusions on which to base the dietary treatment

EFFECT OF DIET ON THE SURVIVAL OF MICE INFECTED WITH PNEUMOCOCCUS

Type I

Exp No	Diet	Dose	No of mice	Number of surviving on day indicated 1	2	3	4	5	6	Average Survival (days)
I	Whole-wheat bread	10^{-4}	24	24	9	4	3	1	0	1 71
	White bread	10^{-4}	25	25	19	16	14	13	11	3 92
II	Whole-wheat bread	10^{-6}	25	25	9	6	2	1	1	1 76
	White bread	10^{-6}	25	25	19	12	12	10	9	3 48

COMPARATIVE NUTRITIVE VALUES OF *GHEES* AND CERTAIN HYDROGENATED VEGETABLE OILS

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THE comparative nutritive values of animal and vegetable fats have been a subject of great controversy during recent years Schantz *et al*[1] found that rats on mineralised skim milk fortified with butter fat showed superior growth as compared to litter mates on vegetable oils homogenised with mineralised skim milk at 3 per cent level Vitamin A, D and E contents were kept identical in all the groups Later on, however, they found that the superior growth rate of animals getting butter fat was seen only in those diets, where the sole carbohydrate was lactose The superiority of butter fat disappeared when lactose was replaced by dextrose, sucrose, dextrine or starch (Boutwell *et al*[2]) Boer and Jansen[3] have found that the food values of vegetable oils and margarine, even after the addition of vitamins A and D were lower than that of butter. Dutt[4] has mentioned that the utilization of the fatty acids of hydrogenated fats was about 3 per cent less than butter fat and that calcium absorption was 14 per cent lower on hydrogenated fat than on butter fat diet. On the other hand, Von Euler *et al*[5] and more recently Deuel *et al*[6] and Henry *et al*[7] did not find any difference in the growth rate of rats on an adequate ration when given either butter-fat or vegetable fats like corn oil or margarine

In view of this difference of opinion and on account of the prevalence of the use of hydrogenated fat in our dietary, it was decided to carry out an experiment regarding the comparative nutritive values of ghees (both cow and buffalo) and hydrogenated vegetable oils or as they are popularly called, "Vanaspaties". Further, as all the previous work was for short durations, it was decided to examine the effect of feeding "Vanaspaties" over three generations of rats, for it is well known that bad effects of a deficient diet may not often be apparent in the first generation but the adverse symptoms may appear in the 2nd or even 3rd generation. This work was taken in hand in 1944, and many of the references cited in this paper came to our notice, when our work had progressed almost to completion.

The experimental technique followed is given below: Weaning rats, aged 4 weeks were removed

from our stock colony and were divided into ten groups. Each group was given the same basal ration, but different fats were added to the different groups. The following fats were examined: cow ghee, buffalo ghee, 3 brands of hydrogenated ground nut oil (henceforth called H.G.N. 1, H.G.N. 2 and H.G.N. 3), three hydrogenated cotton seed oil (H.C.S. 1, H.C.S. 2 and H.C.S. 3) and 2 samples of hydrogenated sesame oil (H.S. 1 and H.S. 2). The hydrogenated fats were purchased from the local market, whereas the ghee samples were supplied periodically by the Director, Dairy Research Institute, Bangalore. The basal ration hereafter called diet A used during the first six weeks of experiment was composed of cane sugar—62 parts, casein (alcohol and ether extracted)—24 parts, mineral mixture (McCollum, *et al*[5]) 4 parts and yeast (petroleum ether extracted) 5 parts. To this 5 parts of ghee or Vanaspati was added 5γ of carotene and 1γ of calciferol was given to each rat per day. Smaller amount of vitamin supplements was given to the ghee rats, so that the amounts of vitamins received by them was of the same order as that in the Vanaspati animals. In a preliminary experiment, the growth obtained on such a diet was rather poor and it was traced later to the poor quality of yeast at our disposal. The diet was therefore slightly modified by administering 10 c.c. of skim milk per rat per day, when the growth became satisfactory, though not as good as that of rats in our stock colony. The weight of the animals were taken once weekly.

From the seventh week onward, until they were discarded, the rats were shifted to a cereal diet (diet B), having the following composition: Maize—66 parts, wheat—22 parts, casein—9 parts, yeast—2 parts, NaCl 0·5 parts and $CaCO_3$ 0·5 parts. Ninety five parts of this diet was mixed with 5 parts of ghee or vanaspati, each group receiving the same fat it was getting during the previous period. In addition, each rat in all the groups received daily 10 c.c. of skim milk and 5 gm. fresh greens, usually lucerne or berseem. The first six weeks in the fat-free diet were intended to give a quantitative idea about the comparative nutritive values of the different vanaspaties with regard to each other as well as to the animal-fat like ghee. The change over to the adequate cereal diet was used for two purposes. Firstly, whether the inclusion of vanaspaties to daily natural diet continuously over three generations would have any bad effect. The diet B represents a very good vegetarian diet, containing abundant quantities of vitamins and minerals. Secondly, it has already been mentioned that diet A is a sub-optimal feed containing barely sufficient vitamin A and probably slightly deficient in certain B-vitamins. The switch over to a super abundant diet helped us to examine whether the supply of excess of vitamins was helpful in dietaries containing hydrogenated fats.

As soon as the animals were 4 months in age the females of each group were mated with the males of the same group, *i.e.*, receiving the same fat. The number of females giving birth to litters as well as the number of live litters born was used as the index of reproductive capabilities and the number of youngs alive at the time of weaning showed the lactating power of the mothers of the various groups.

The litters thus born in each group were mixed at the time of weaning and six best males and six best females were selected and kept on the diet A plus the respective fats their parents were receiving. The experimental procedure followed was the same as before and the third generation of offsprings obtained were treated exactly in the similar way. In this way the continuous effect of feeding each fat through three complete generations were observed.

It was found that the growth rate of rats on the fat-free diet and vanaspaties was slower than those on the same diet *plus* cow or buffalo ghee. This effect was more pronounced in the male rats and the rates were very significantly lower in the second and third generations, the differences being not so pronounced in the first generation (Table I). It was further observed that as soon as the rats were put on the diet B, the vanaspati rats made very rapid gains in weight and equalled the weight of ghee rats within 4-5 weeks. No difference in the reproductive ability between the various groups was observed, but this was most probably due to the fact that the animals of all the groups were receiving super abundant diet at the time of mating and rearing the litters.

After the youngs in the various generations were weaned, their parents were sacrificed and the livers of these adult rats were examined for vitamin A content. In spite of the fact that all the groups were receiving plenty of carotene in the form of green fodders (5 gms daily for the last 3-4 months of their lives), the livers of the vanaspati rats contained much less vitamin A than those of ghee fed rats. The results are very significant in spite of the fact that ghee animals received slightly more of vitamin A. The amount of vitamin A and carotene fed to ghee rats through the ghee was very small as compared with the total amount of carotene fed as greens. Thus the total carotene ingested daily through greens was about 250-300 I.U. while the maximum amount of vitamin A and carotene supplied through ghee never exceeded 20 I.U. It is reasonable to believe therefore that the presence of "vanaspaties" in the diet interferes with the absorption or utilization of carotene.

This finding provides a clue for the slower growth rate of the Vanaspati animals particularly in the second and third generations. As mentioned before, the animals during the first six weeks of fat free diet received only 5γ carotene daily. This amount is definitely suboptimal for rapidly growing animals. In vanaspati groups, even this amount is not fully utilized, so that the diets become further deficient. In the first generation, the rats were obtained from our stock colony and had, therefore, a good reserves of vitamin A, when they were put under experiment. These reserves made good the deficient supply of carotene through the vanaspati diet and thus the growth rates were not significantly different from those of the ghee fed animals. In second and third generation where no such large body reserves of vitamin A were present, the animals of both the vanaspati and ghee groups showed lower growth from the very beginning, as sub-optimal quantity of carotene was being supplied but even then the ghee groups made the most effective utilization of the small quantity supplied and thus showed greater growth than the vanaspati rats. As females are known to have a lower requirement of vitamin A (Coward *et al*[9]; Brenner, Brookes and Roberts[10]), the differences of the growth rates in this sex between the various groups were not so prominent.

Not only the absorption of carotene was affected in the presence of vanaspaties, but we have reason to believe that perhaps absorption and utilisation of vitamin B complex were also interfered with or the requirements for such vitamins were enhanced on Vanaspati containing diets. Extensive alopecia was seen in the animals of the Vanaspati groups, especially in those of the second generation, whereas the ghee fed animals, were not affected at all. In another experiment using chicks as experimental subjects, extensive B-deficiency symptoms like curled-toe paralysis, dermatitis, poor growth etc., were seen in birds fed vanaspati in addition to basal mash, whereas similar birds fed the same basal ration plus cow ghee remained immune. The slightly better growth rates of the vanaspati rats in the third generation might have been due to the use of a fresh and hence better type of yeast, the previous stock used during 1st and 2nd generation having been exhausted (Table I). When this paper was being written up, we came across a short summary of a paper by Boutwell *et al*[11], who have found that rats on purified diet, containing medium quantities of B-vitamins maintained a normal growth rate when fed butter fat. The growth was however subnormal if corn oil was substituted for butter fat. Growth rates were excellent in the presence of either fat when the level of B-vitamins was increased three fold.

TABLE I

AVERAGE INCREASE IN WEIGHTS IN GMS FOR THE FIRST 6 WEEKS AFTER WEANING AND THE VITAMIN A CONTENT OF LIVER OF RATS IN VARIOUS GROUPS

For three generations

Generations	Cow ghee	Buffalo ghee	H G N 1	H G N 2	H G N 3	H C S 1	H C S 2	H C S 3	H S 1	H S 2
	Brands									
	Males									
1st Gen	92 8	90 0	80 8	82 9	82 0	75 5	86 6	87 8	77 8	99 6
2nd ,,	59 3	62 8	36 3	40 2	371 1	34 2	40 2	39 3	46 8	46 5
3rd ,,	65 5	63 4	51 9	49 2	51 3	50 0	57 9	50 0	55 5	46 3
	Females									
1st Gen	71 9	69 9	65 2	69	66 3	64 2	67 7	66 6	70 2	66 9
2nd ,,	54 2	48 5	47 2	43 2	35 2	31 3	38 8	38 8	38 0	34 3
3rd ,,	54 6	53 7	52 9	44 9	55 4	50 7	49 1	49 7	58 5	57 9
	Vitamin A content r/gm liver									
Average from all generations	102 71	66 78	34 8	40 08	44 22	39 98	39 93	46 39	46 50	56 99

Similarly, it is quite possible that the absorption of calcium may also be affected in presence of vanaspaties (Dutt[4]). This aspect of the problem is now being examined.

In conclusion, it may be stressed that whereas the addition of vanaspaties to a super adequate diet may not have any harmful effect, their inclusion in diet deficient in vitamins and minerals may have deleterious effect. We have already mentioned that switch over from diet A to the rich diet B helped the vanaspati rats to gain rapidly in weight. That the growth inhibiting property of vanaspaties is

absent in a super adequate diet, is further shown in another experiment Rats of the second generation from the various ghee and vanaspati groups were put directly after weaning on the diet B plus ghee or vanaspati at 10 per cent level, the rats in the various groups receiving the same fat as their parents were getting. Five grams of green and 10 c c. of skim milk were also given to each animal daily. In spite of the higher level of fat given, the vanaspati animals showed as good growth rate as the ghee fed animals, whereas as may be seen from (Table I), their litter mates on the restricted diet plus vanaspati showing very poor growth These observations explain the findings of Deuel *et al*[12], who successfully reared ten generations of rats on a diet containing margarine as the sole fat The ration used by these authors was skim milk powder 23 76 per cent vitamin A, fortified margarine (15000 I U of vitamin A, per lb) 9 24 per cent ground whole wheat 66 per cent, and NaCl—1 per cent As this diet contained dried skim milk and whole wheat, it was very rich in B-vitamins and the extra vitamin A added to the diet was more than the optimum requirement of rat under all physiological conditions It is, therefore not at all surprising that the authors had no difficulty in rearing healthy animals on such super adequate diet Fuller details and further experimental findings will be published in the *Indian Journal of Veterinary Science and Animal Husbandry* *

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* Our thanks are due to Dr N D Kehar, Officer-in-charge, Animal Nutrition Section for general guidance and helpful criticism. The expenses of the work have been borne by a grant from the Imperial Council of Agricultural Research

BOOK REVIEWS

Patterns of Peace-making—By David Thomson, E Meyer and A. Briggs (Kegan Paul, Trench Trubner & Co, Ltd) Pp 399, Price 21s

This is a remarkable book and has more than maintained the high reputation that has been built up by the 'International Library of Sociology and Social Re-construction' It is a comprehensive treatise dealing both with the theory and practice of modern peace-making The historical and social background of peace are explained with commendable insight and penetration. The authors emphasise in particular the programme of psychological, educational, economic and social re-construction both in the national and international spheres International covenants like the League of Nations and the United Nations Organisaion, treaties like the Kellog Pact, which outlawed war and purported to abandon war as an instrument of national policy, will be of no avail unless they are supported by national planning and reconstruction on the one hand and socio-economic co-operation on an international scale on the other In this connection the authors have included in the appendix the United Nations agreements like the Atlantic Charter, The Three Power Conference Declaration, The Teheran Declaration and the Crimean Declaration , constitutions of the International Labour Organisation, the U N.R R.A., the Food and Agricultural Organisation and the Bretton Woods Agreements add to the usefulness of the valuable treatise.

The years since 1914 have been variously described. Some have described them as 'Thirty Years of War' ; others have characterised the inter-war years as 'twenty years' truce'. In fact the second world war may be regarded as the second act of the grim drama the curtain of which was raised in 1914 We commonly speak of the Second World War as 'a war to end war' and love to think in terms of the 'brave new world' we propose to create in the future. But in the back ground of this idealism there is the

ever present question shall we be able to prevent the opening of the third act of the terrible drama which began in 1914

The main conclusion and the central thesis of this book is that peacemaking must concern itself with social and economic problems as well as with political and security problems: and that peacemaking will succeed in so far as national plans for providing social security and economic welfare are regarded and treated as the internal aspects of a wider international effort with the same end in view Ideally national plans would be facets of an international plan national machinery for social security would be branch organisations of international functional organisation serving the same ends

The aim of planned settlement is what the authors have called 'four freedoms'—individual and national security, prosperity and welfare leading towards an international society

The book was begun in 1943 and published in 1945 It is already out of date For one thing there is nothing about the UNESCO in the book But a book dealing with matters of topical interest is bound to suffer on account of later developments The present treatise is a valuable addition to the library of international thought.

N. C B.

Manual of Pharmaceutical Specialities, Serums and Vaccines—Published by Dr Herbert Ludwig, M.D., Lecturer at the University of Basle, Chief Physician to the Basle Municipal Hospital; edited by Verlagagesellschaft Beobachter Ag., Abteilung. "Repertorium pharmazeutischer Spezialpraparate", Elisabethenstrasse 15, Basle Switzerland, first edition 1946, bound in linen, frs 48—(Swiss) 1st supplement frs 23 50 (Swiss)

This compendium gives a list of about 13,000 specialities on 1300 pages normal directory size Also a list of the manufacturers with the exact address in many countries. Besides in Switzerland itself the popularity of this compendium was marked by the fact that the first edition was completely sold out within 3 months. The first supplementary will appear in 1947.

For the pharmaceutical and medical profession such manual is imperative, because of the everyday used ethical pharmaceutical specialities stated in the book (13,000 curative remedies used throughout the world made by about 2000 companies). It is a valuable help for the medical practitioner, for the pharmacist, for the dispensing chemist, for the dealer in drugs and also for the manufacturer.

It is the first book after the war giving full information about a number of specialities of the whole world

The book is valuable also because it contains references about literature, clinical tests, doses and prices; it can be recommended to everybody interested in pharmaceutical specialities. It makes independent of casual prospectuses and provide a well arranged account of information

C. A. R

Science and Scientists in the Netherlands Indies—Edited by Pieter Honig and Frans Verdoorn Pp xxiv+491 (illustrated). Published by the Board for the Netherlands Indies, Surinam, and Curacao, New York City, 1945 Price $4 00 or £1-1-0

The editors have presented a picture of the "development and status of a number of branches of the natural science, pure and applied, in the Netherlands Indies" Some political aspects of the country could not be avoided in the treatment of such a vast and varied subjects of a country, which, though small, is one of greatest importance in the east as regards vegetable, animal and mineral resources and the culture and religion of the people residing in the picturesque island homes

The work consists off

(1) Original articles, prepared especially for this volume, dealing with the development or status of various branches of science in the Netherlands Indies.
(2) Reprints of similar accounts previously published elsewhere, several of which originally appeared in Dutch and are now being available in English
(3) A number of travel accounts and impressions by distinguished visitors in the past, often offering delightful glimpses (scientific and otherwise) of life and nature in the Netherlands Indies.
(4) A number of shorter articles--notes, biographical sketches, reviews, etc ("*Serta Malesiana*") -comprising material often of interest from the view point of the promotion of North American-Netherlands Indies relationships.
(5) A list of scientific institutions, societies, and reasearch workers in the Netherlands Indies at the time of the Japanese invasion. (See *Science and Culture*, July, 1946, p 49).

The flora of India particularly in the east is predominantly marked by Malayan element. The study of Indian vegetation is not complete without the study of the Malaysian flora and C. E. & H. A. Von, Rumphius', Blume's, Treub's, Blanco's and others monumental works. These old contributions are of considerable importance towards advancement of our knowledge of Botany of the East and the Far East.

The famous Botanic Garden of Buitenzorg and its well known Herbarium, founded in 1817, bears also close similarity to the thirty years' older and

larger Royal Botanic Garden, Calcutta, and its world famous Herbarium Experiments on the introduction, and acclimatization of many economic plants, such as tea, cinchona, sugarcane, tobacco, rubber, jute, spices went on hand in hand for over a century in both these institutions. The two gardens and their botanists have thus jointly advanced the botanical and floristic studies in the east with the help of the living materials of the garden and irreplaceable herbarium specimens of the two herbaria Buitenzorg, however, solved many intricate problems associated with the cultivation of the delicate but vitally important plant namely *cinchona* by carrying on experiments on modern lines both in the laboratory and in the field and lately with the help of the famous organization known to the world as "Kina Bureau" whose experts encouraged private cultivators in Java to follow the latest scientific method of cultivation of Cinchona plants This is why Java became the greatest centre of quinine production in the world It is regrettable that though India introduced *Cinchona* earlier, she lagged behind in this respect It is however, hoped, that she too by availing herself of the latest scientific knowledge and information will solve the question of production of quinine in sufficient quantity to meet her own requirements It is high time therefore that experiments on a vast scale both in the field and laboratory on modern scientific methods should be undertaken in India without further delay. Both the Royal Botanic Garden, Calcutta, and the Botanic Garden, Buitenzorg, (Java) should continue to collaborate as in the past for introducing the common vegetable resources of the east towards furthering the cause of biological sciences for the good of humanity.

India's alliance with the peoples of Malaysia is of great antiquity. In fact, Indian culture is by no means a less influencing factor over the ancient peoples of these islands and last but not the least there exists a common natural bond between the two peoples of the East not only with regard to the spiritual aspect of life but also their struggle for political freedom which is now dawning fast upon these ancient lands.

"Before the Westerners found the way to tropical Asia, it had been for centuries a "colonial area" for both Hindus and Chinese That meant - just as it does to-day - on the one hand exploitation by profiteering merchants and tribute seeking conquerers, but on the other hand cultural enrichment, whether directly through active proselytizing or indirectly through imitation and adaptation. It was particularly the Hindu expansion in the early centuries of our era that introduced to the primitive, pagan, tribal societies of Southeast Asia the higher forms of religion, philosophy, literature, architecture and political and social organization. The temples and palaces of present-day Burma, Thailand, and Bali and such classic monuments as Angker in Cambodia and Borobudur in Java are symbols of the mighty impulses that came from India. These cultural influence of China was on the whole, limited but predominates among the Annamese in the coastal area of French Indo-China, here Confucianism, Buddhism, and ancestor worship mingle in true Chinese fashion and the stamp of Chinese tradition

"Later, about the fourteenth century, another outside force, Islam, made its impact on the region Although its source was in the Near East, the new religion and its concomitant socio economic tenets were carried to the Indies by Mohammedan merchants from north western India It spread steadily from the trade centres along the Strait of Malacca eastward and north-ward, and by the time the Portuguese arrived, Islam was dominant in the coastal regions of the Indies and had pushed north as far as Mindanao "

It is a pity that Dr Jan O M Broek in his article on this aspect of Malaysian culture has not further dilated upon the historical, cultural and spiritual aspects Whatever apparent benefits might have accrued upon the people of the east during the brief period of Western European invasions and contact, the world of to-morrow is sure to adjust on the more broader principles of "ruling a country by the people and for the people" The Tropical Eastern Asia with India as the Centre ,as the author hints, is sure to play a great part in the general emancipation of the people in the east and thereby contributing much to the future peace of the world

There is also a tendency of the various authors to give a little exaggerated account of the activities of the Dutch people and the various institutions established by them evidently due to lack of information about the work done by other similar institutions and numerous workers in various parts of the tropical and the temperate world.

Nevertheless the magnificent volume illustrated with many interesting photographs and pictures will prove to be of considerable interest to all scientists, politicians and the public men at large The authors of various articles and the editors deserve sincere thanks and congratulations for producing such a valuable treatise which, the reviewer believes, will be welcome by all particularly by the natives of Netherlands in near future when the people of these ancient Islands will emerge out as an independent nation and their friendly relation with India as a free nation will be strengthened by the contributions of the great Dutch Scholars whose names will go down in the history of Malaysia and will be remembered by the Malaysians for all time to come

K. B.

Progress in Science—By W. L Sumner. Published by Basil Blackwell, Oxford. Price 8*s*. 6*d* net

During the war, the author had the unique privilege of talking science to the men and women of the armed forces of His Majesty's Government in Great Britain. These lectures have now been compiled in the form of an illustrated and attractive

book, under review, to reach the thousands of lay civilian readers, equally uninitiated in the sciences Today, it is fateful to plead ignorance in advances in science, which profoundly affect our lives and thoughts. "If you do not think that you are very interested in science" writes Mr Sumner, "science is certainly interested in you"

Any account of the progress in science needs must be selective, and the author has done well in choosing his subject from the most recent developments in the applied sciences The advances in electron microscope, television, radar, betatron, atomic energy, jet propulsion and gas turbine, chemotherapeutic and antibiotic drugs, plastics, and in genetics, all of which have proved of inestimable service to mankind, in war as well as in peace, have been presented in a remarkably simple and attractive style Even the developments in insecticides like D.D T., vitamins, histamine and shock therapy, blood transfusion, cancer, inoculation against diphtheria, typhus and yellow fever, radiology and the like have not escaped the author's attention, and have been briefly referred to in the concluding chapter It is a highly entertaining and instructive monograph in science and deserves to be widely read

S. N S

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

ATOM BOMB EXPERIMENT IN THE PACIFIC OCEAN AND ITS POSSIBLE EFFECT ON THE MARINE LIFE FORMS OF THE INDIAN OCEAN

THE possible destructive effects on the flora and fauna of the seas as a result of the disposal of explosives in the Indian Ocean was stressed by me in a previous communication[1] The authorities subsequently assured that they would dispose off the explosives in a harmless manner.

Series of experiments with the Atom Bomb in the waters of the South East Pacific Ocean on the Bikini atoll lying near the Marshall group of island were performed in July 1946 and elaborate arrangements were made for specialists in analyzing mass-scientific data It had been announced that expert biologists were also among the experts with a view to studying the effect of explosion of the atom bomb on the flora and the fauna of this portion of the sea before and after the experiment Such a study will undoubtedly prove to be of considerable value to science

The flora of this portion of the Pacific may be classified nto (i) *Flora of the bed of the sea*, (ii) *Submerged rooted flora*, (iii) *Floating submerged surface plankton flora*; (iv) *Flora on Coral reefs*; (v) *Flora along the margin of islands growing in different successions*, (vi) *Flora within the tidal zones partly floating and partly attached* and (vii) *The terrestrial flora on the mainland of the islands in and about the zone of experiment*. It is a well-established fact that the fauna is dependent on the marine vegetation for food and shelter. It is therefore obvious that the fauna of this tropical belt of the ocean has been affected, as the vegetation of this belt of the ocean must have been damaged, destroyed or partly scorched or burnt, even though the destructive range of the Atom Bomb might have been localized

The first shocking effect on the vast mass of submerged and floating plant-life, must have been the total burning of all the life forms within the area where the bomb exploded. The submerged coral reefs, the shallow island, the rocky beds of the ocean and the near about islands overgrown with marine and brackish water flora and fauna are likely to be seriously affected if not absolutely sterilized, either half burnt or scorched leading naturally to putrefaction of tons of vegetation and marine animals of numerous types Such an insanitary condition of this portion of the sea will result in the accumulation of poisonous gases The entire area might turn out to be the second "Krakatoa" after the great volcanic eruption.

The factors favourable for the renewed growth of vegetation and consequently fauna depending on the vegetation will be absent for sometime to come and rehabilitation of the fauna is likely to be deferred for a long time.

Then again the summer, the rainy and the autumn seasons are the three main reproductive periods of both the plankton and submerged flora and fauna, fixed or floating. The sudden death of the organisms *en masse* might lead to prolonged delay in their replacement, as the alternation of the vegetative and the reproductive periods in their life

history will be seriously disturbed, as a result of various physico-chemical changes reacting on the natural medium of sea water which sustains numerous life forms

It is wellknown to the biologists that the marine phytoplankton and phyto-zooplankton are beneficial to the various kinds of edible sea fishes and other marine animals They are also important agent for the supply of oxygen to the water and are abundantly used for human consumption and various other economic purposes These plankton flora and fauna might disappear once for all within and outside the affected zone It is true, as it was stated by an American authority, that "the world is foolish to rely so much on wheat supplies, as there are equally good crops to be harvested from the sea There was enough nutritious vegetation grown in the Sargasso Sea alone to feed all Europe", he said, "if only it were, harvested and prepared for human consumption "

'Seaweed is a valuable food, containing silica, lime, potash, nitrogen and carbon There is seaweed to be had for the asking on any seashore But take the seaweed that is washed up, don't tear it from rocks It is important to remember that the growth of seaweed on rocks prevents coastal erosion '

Polunin the wellknown biologist insisted on the wartime use of plankton as there is sufficient possibility of 'obtaining food direct from the marine plankton ' It is wellknown that many macroscopic animals such as fishes and seals which are important for man's food and fuel, are to a very large extent dependent upon plankton ultimately and indirectly on phytoplankton for their own food[10] Most of the fish oil comes from the oil stored in the floating plankton vegetation If the chief source of food of the fishes of economic importance is lost or diverted in other direction, the valuable fish fauna in this region will disappear with the phytoplankton also

It may therefore be naturally apprehended how and to what distance the destructive effects of Atom Bomb explosions on the marine flora and fauna have extended It is quite obvious that the oceanic currents, *viz*, the warm equatorial currents extending from the Pacific to the Indian Ocean, will circulate not only the harmful effects of the bomb but at the same time will, it may be expected, restore the normal physico-chemical and biological conditions of the water in and around the affected area But at the same time the oceanic currents operating in this zone may carry with it, to a certain extent, the harmful elements of the Atom Bomb and thereby might affect the life of the Indian marine and brackish water flora and fauna in the Indian Ocean and Bay of Bengal as some of the flora and founa migrate from the Indian Ocean to the far eastern Pacific Ocean and *vice versa* Many a new and rare sensitive species and life forms of considerable scientific interest might thus altogether be extinct. A general review of the marine algae of the western coast of India[2, 3] and a scrutiny of the literature on algae of the Indian Ocean reveal that there exists more than fifty per cent warm Pacific element in the algae of the Indian Ocean [1, 5, 6, 7, 8, 9 & 12] The results of the Atom Bomb is therefore of some consequence on the marine flora of the Indian Ocean as well. It may be that some of the Indian element would find its access into the affected zone of the Pacific. There is likelihood also of Japanese forms migrating intc the Southern Pacific

But how far these migrating forms will acclimatize within the affected zone under the altered ecological conditions as a result of Atom Bomb experiment, it remains to be investigated

Nevertheless, the beneficial aspect of the explosion needs watching carefully There is the possibility of the deposit of masses of floating and submerged dead and decaying Diatom flora which is likely to lead to the formation of Diatomaceous earth in course of time This siliceous earth is a valuable mineral for its various commercial importance[11] Further the dead and decaying seaweeds and animal organisms might be utilized partly a food, fish oil and organic manure and thereby help to solve the problem of 'grow-more-food' in the areas along the coast-line of the Bay of Bengal and the Pacific Islands

May I therefore invite the attention of the Biologists who are in charge of the biological investigation of the Atom Bomb experiments to the above points

K Biswas

Royal Botanic Garden,
Calcutta, 18-9-1946

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7 ——— Some Marine algae from the northern part of the Arabian Sea with remarks on their geographical distribution *Del Kgl. Dansk. Viden Sel. Biolog Medd*, *11*, No 6, 1934.

8 Gardiner, J S, List of marine algae collected at the Maldive and Laccadive Islands *Jour Linn. Soc. Bot*, London, *35*, No. 217, 1933.

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[11] Smith, G M, The fresh water Algae of the United States, New York and London
[12] Svedelius, N, Report of the Marine Algae of Ceylon, No 1, Ecological and systematic studies of Ceylon species of *Caulerpa*, Biological results of the Ceylon Pearl Fishery, No 1, Art 4, 1904

PURIFICATION OF STYPHNIC ACID AND SOME OF ITS PROPERTIES

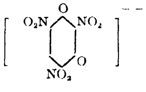
STYPHNIC acid as generally met with is coloured red or brownish yellow, and is about 96 per cent pure (titanous chloride method[1]) Among attempts to purify the product, a chromatographic separation of the impurities was found promising, when a benzene solution of a test sample was passed through a column of talc, the impure fraction was held in the upper layer In the search that followed for a solvent more effective than benzene for dissolving impure styphnic acid samples for chromatographic examination, an interesting, although unexpected, result ensued using kerosene oil. It was found that on heating a sample of impure styphnic acid in kerosene near its b p, a pale yellow solution resulted, leaving behind a red, lumpy mass rich in impurities On cooling, the supernatant yellow solution rapidly yielded colourless, silky needles This observation led to the adoption of the following method for the purification of styphnic acid on a laboratory scale

Purification —25 gm. impure styphnic acid as obtained in the manufacture, together with 500 ml of kerosene (distillation range 150°-250°) are taken in a flask fitted with an air-condenser, and the mixture brought to about 140° in a paraffin oil bath After maintaining this mixture at this temperature for about 15 minutes, the supernatant solution is decanted into a beaker Pure styphnic acid immediately starts crystalising in colourless, silky needles Most of the styphnic acid crystalises out from the solution as it cools down to room temperature The clear solvent is decanted back into the original reaction flask and the residue therein subjected to the above treatment The process is repeated twice.

The combined crystals from the various extractions are washed on a Buchner filter at the pump with fresh, cold kerosene and finally with carbon tetrachloride and dried at 100°. In this manner, about 85 per cent of the total solids is recovered from the impure mixture as pure styphnic acid and 90 per cent of the original quantity of solvent is available at the end of the operations for further use. Styphnic acid obtained by this process is 99 8 per cent pure, as determined by the $TiCl_3$ method and by direct combustion.

As it comes out from hot kerosene, styphnic acid is colourless, but during the subsequent operations of filtration and washing, where it is difficult to work under absolutely moisture-free conditions, it readily picks up moisture and becomes yellow immediately. Again, working with small quantities and under rigorous conditions, it has been possible to obtain styphnic acid in an almost colourless state by crystallising from petroleum ether or CCl_4, although the solubility is very limited. The literature available to us, however, contains no statement other than that it is yellow

The colourless substance becomes yellow not only with water, but also on melting Again, the yellow aqueous solution becomes colourless on strongly acidifying with HCl It is, therefore, reasonable to assume that the pure, dry, undissociated molecule is colourless, and that the yellow colour is the property of the dissociated styphnate anion, as has already been suggested by us elsewhere.[2]



Picric acid[3] and tetranitroresorcinol[4] too, two other allied compounds, have been known to behave similarly

During the course of the investigation it became necessary, in the absence of firm data, to determine the solubility of styphnic acid in some of the common solvents The following approximate results were obtained —

Solvent	*Solubility*
Ether	1 7 to 1 9% in 100 c c. soln at 22-25°C.
Benzene	1 6 to 1 8% " " " "
"	8 6% in 100% of hot solvent at its b p.
Carbon tetrachloride	0 5% in 100 c c solution at 22-25°C
Rectified spirit	2 75% " " " "

The residue left over from the kerosene treatment was further extracted with benzene to remove the small quantity of styphnic acid it contained. The benzene insoluble fraction is a red amorphous solid, soluble in acetone and in alkali, and on heating carbonises without melting. It is largely in the nature of a dye, dyeing silk and wool a brownish red from faintly acid solution.

The authors wish to thank Dr H R. Ambler, and Mr M. D. Owen for suggestions, and the

Director of Technical Development for permission to publish it.

M. SRINIVASAN
B. N. MITRA

Inspectorate of Military Explosives,
Kirkee, 3-1-1947.

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A NOTE ON BREAKING DORMANCY IN *CROTALARIA MEDICAGINEA* LAMK

IN connection with a cytological study of *Crotalaria medicaginea* Lamk, it was observed that its seeds germinate very poorly under laboratory conditions—it varies between 1 per cent to 3 per cent To break the dormancy various methods, such as, soaking the seeds in warm water at 40°C, rubbing with sand, and exposing the seeds to vapours of ethylene chlorhydrin (1 c c in a litre jar) for 24 hours were tried with little effect These methods were tried with seeds that were collected freshly and also an year earlier

Where germination is inhibited by hard seed coat, dipping the seeds in conc. H_2SO_4 has been known to give good results as in cotton[1], beach pea and silvery pea[2]. Seeds of *C medicaginea* were, therefore, dipped in conc H_2SO_4 for various durations (Table I) after which the seeds were throughly washed in running water. The little acid that might have still remained was neutralised by washing with 5 per cent solution of Na_2CO_3. After further washing, the seeds were sown in sterilised sand for germination Then germination was recorded 3 days later when the following results were obtained·

TABLE I

GERMINATION % OF SEEDS AFTER DIPPING FOR DIFFERENT DURATIONS IN CONC H_2SO_4

	Minutes						
Duration of treatment	0	5	10	20	30	40	50
% germinated seeds	2	15	29	77	96	98	100

Thus, it is seen that dipping in conc. H_2SO_4 improves the germination of seeds Treating for more than 30 minutes is, however, not to be recommended as the seeds are injured and the subsequent growth of the seedlings is thereby adversely affected.

Germination of *C medicaginea* seeds is, therefore, prevented by hard seed coat This plant, however, occurs in abundance as a weed during the monsoon. Germination in nature is perhaps made possible by the decay of the seed coat due to temperature and the acids present in the soil

I wish to acknowledge the help given by Mr K Das in preparing this note

N SATYANARAYANA RAO

College of Agricultural Research,
Benares Hindu University,
Benares, 17-1-1947

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SOME OBSERVATIONS ON NICKEL DEPOSITION BY CHEMICAL REDUCTION

IN a recent paper Brenner and Riddell[1] reported that nickel could be deposited from an aqueous solution of nickel chloride and sodium hypophosphite, with sodium citrate as a buffer, without passing electric current. They obtained nickel deposits on iron, cobalt, nickel, gold, palladium and aluminium, but failed to get the same deposits on platinum, copper, brass, zinc and lead

While working with the above mentioned solution, it was observed that when a copper wire was used for suspending iron panels, nickel deposit appeared on the copper wire along with the iron panels In the same solution when copper and iron panels were suspended simultaneously without any connection or separately, nickel deposit appeared only on the iron panels and not on the copper panels.

It was further observed that when copper and iron panels were connected by means of a copper wire externally or internally by direct contact, nickel deposit appeared on both the panels. The amount of deposition was approximately proportional to the surface area exposed.

Nickel depositions on platinum and brass were obtained in the same way by connecting them to iron panels externally or internally.

In case of zinc and lead, black non-adherent deposits containing nickel were obtained

The above results were also obtained using ammonium citrate as a buffer.

Nature of the deposits—The nickel coatings obtained by the above method are different from the ordinary electrodeposited coatings, as they are not attacked by B N F reagent solution (containing ferric chloride and copper sulphate) which is used to measure the thickness of the electrodeposited coatings. This reagent could not penetrate a nickel coating of thickness of 0″ 0.070 obtained by the above process even in two minutes at 30°C. The point at which the jet of solution impinged, became black. It is, however, recalled here that an electrodeposited nickel coating of 0″ 0050 thickness would have been completely dissolved by the B N F reagent under the same condition within two minutes.

Further, the action of nitric acid on the coating is interesting. The coatings are not directly attacked very much, but flaking of coatings from iron base takes place and the coatings become black in colour.

The process of nickel deposition as mentioned seems to be electrochemical. The iron panels act as anode and nickel is deposited on brass, copper and platinum as cathodic reaction products. Once a thin film of nickel is formed on the above metals, further deposition can proceed, presumably by chemical reduction process as mentioned by Brenner and Riddell.

Experiments are in progress to confirm the above views.

A detailed paper will be published later on.

A. P. GOSWAMI

Ordnance Laboratories,
Inspectorate of General Stores,
Cawnpore, 18-1-1947

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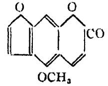
CRYSTALLINE COMPONENTS OF THE SEEDS OF HERACLEUM NEPALENSE

FROM the ethereal extract of the dry crushed seeds of Heracleum nepalense five neutral crystalline compounds, all of which are furo-coumarins, and an acidic crystalline component have been isolated.

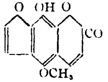
(*i*) A colourless compound, m p. 188-89° crystallizing in long silky needles has been isolated in 0.02-0.03 per cent yield. It is neutral to litmus and indifferent towards ferric chloride. It contains one methoxyl group and is identical with Bergaptene[1] (I) in all respects.



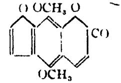
(I)

(*ii*) The second compound, m p. 157-58°, crystallizing in colourless needles, has been isolated in 0.015 per cent yield. It gives no coloration with ferric chloride. The C-H value and methoxyl estimation agree with the formula $C_{12}H_8O_4$ and hence isomeric with Bergapten. It is however remarkable to note that the substance is transformed into Bergapten when refluxed with alcoholic potassium hydroxide in water bath for an hour. Probably the compound is a stereoisomer of Bergapten.

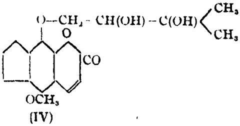
(*iii*) The third component, forming light yellow shining flakes, m.p. 120-24°, has been isolated in fairly good yield, being 0.1 per cent of the weight of the dry seeds. Although it does not respond to ferric reaction, it contains two hydroxyl groups as it readily gives a diacetyl derivative m p. 112°. Methoxyl estimation by Deisel's method indicates the presence of one methoxyl group. When the compound is gently boiled with a mixture of glacial acetic acid and conc sulphuric acid, a phenol (II), m p. 218-19° has been isolated, thus proving the presence of an oxyalkylenated group. On methylation with methyl iodide the phenol gives a furo-coumarin isopimpinellin[2] (III). A close inspection of the properties of the compound reveals similarity with those of Byakangelicin (IV) isolated from the roots of *Angelica glabra* by Noguti and Kawanami[3]. Thus the compound proves to be identical with Byakangelicin.



(II)



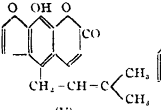
(III)



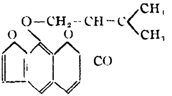
(IV)

(*iv*) The fourth compound crystallising in dull yellow shining plates, m.p. 228°-29°, has been isolated in 0.04 per cent yield. Though it is inert

to ferric chloride, it contains one phenolic hydroxyl group as it readily forms a light yellow monoacetyl derivative, m.p. 137°, and a monomethyl ether, m.p. 113.5°. The properties of the compound are similar to those of Allo-imperatorin (V), m.p. 233°C which has been obtained by Spath[4] by distillation of Imperatorin (VI) at 0.5 mm/Hg



(V)



(VI)

It may be noted in this connection that allo-imperatorin has been obtained synthetically by Spath and co-workers and it has for the first time been isolated from natural sources

(v) The fifth compound, m.p. 231°, crystallising in pale yellow silky needles has been isolated in traces, hence its investigation has not been possible

(vi) The remaining compound, m.p. 202-204°, crystallising in plates, has been obtained in good yield being 0.2 per cent of the weight of the dry seeds The investigation of this compound is in progress.

My best thanks are due to Dr D Chakravarti, D.Sc. for giving facilities to work in his laboratory and valuable advice and keen interest during the progress of the this work and to Mr N Ghosh, for micro-analysis of some of the compounds.

CHANDRANATH BHAR

Organic Chemistry Laboratory,
University College of Science,
Calcutta, 21-1-1947

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A MICRO METHOD FOR THE DETERMINATION OF ACETONE BODIES IN BLOOD

NECESSITY has long been felt for a simple micro-method for the determination of acetone bodies in a small amount of blood. The subject has been studied by various workers and different methods have been put forward. But each one is associated with its inherent difficulties. The purpose of the present authors has been to study the different steps in different methods individually and to accept those which are handy, simple and at the same time give good results, and thus to put forth a modification over the existing methods through their combination in suitable form

The general procedure for the estimation of acetone bodies in blood consists of 3 stages

(i) Deproteinization and desaccharification of the blood
(ii) Conversion of the ketone bodies to acetone and its distillation
(iii) Estimation of acetone, thus obtained

For deproteinization, it has been found that the method of Weichselbaum and Somogyi[1] *i e*, the use of freshly prepared barium sulphate is very simple and the result is also good

For desaccharification use has been made of alkaline copper sulphate solution as usual The acetoacetic acid and hydroxy butyric acid can be converted to acetone respectively by sulphuric acid and pot dichromate

While for the final estimation of acetone, obtained after distillation of the resulting reaction product, the colorimetric method of Behre[2] has been found to be most convenient one, for it is less time consuming and simpler at the same time, as compared to the gravimetric method of Weichselbaum and Somogyi (*loc cit*) though both of them give comparable results

Several estimations have been made with known amounts of acetone bodies alone and when added to blood and the percentage of recovery in each case has been as good as that recorded by other workers in the field (*i e*, about 80 per cent) The results are shown in Table I & II

Table I gives the amount of acetone, diacetic acid and β-hydroxy butyric acid recovered after carrying out the process of deproteinization and desaccharification by the two methods, from known amount of substances

TABLE I

Substance	Amount used in mg	Amount recovered in mg		Percentage of recovery	
		Behre's method	Somogyi's method	Behre's method	Somogyi's method
Acetone	0.312	0.269	0.271	86.2	86.5
	0.156	0.129	0.132	82.7	84.6
	0.078	0.0672	0.0673	86.1	86.3
Diacetic acid	0.792	0.726	0.711	91.6	89.7
	0.396	0.388	0.371	97.9	93.6
	0.198	0.180	0.179	90.9	90.4
β-hydroxy butyric acid	0.21	0.176	0.162	83.8	77.0
	0.105	0.079	0.0784	75.4	74.6
	0.126	0.104	0.097	82.4	76.7

Table II indicates the recovery of acetone, diacetic acid and β-hydroxy butyric acid when added to blood.

TABLE II

Substance	Amount used in mg	Amount recovered in mg		Percentage of recovery	
		Behre's method	Somogyi's method	Behre's method	Somogyi's method
Acetone	0 156	0 120	0 118	76 9	75 6
	0 078	0 0561	0 055	71 1	70 5
	0 039	0 028	0 0281	71 8	71 9
Diacetic acid	0 792	0 724	0 731	92 2	92 3
	0 396	0 382	0 380	95 9	95 9
	0 198	0 180	0 182	91 8	91 9
β-hydroxy butyric acid	0 21	0 153	0 159	72 7	75 7
	0 105	0 075	0 074	70 9	70 0

The amount of blood required for the estimation is only 5 c.c

Several samples of blood from normal as well as diabetic patients have been studied and the amount of acetone bodies (calculated as acetone) in normal Bengalees has been found to range between 0 5–0 7 mg per cent In case of diabetics it has always been found to be above 1 mg per cent the highest value recorded by the authors being 4 62 mg per cent.

Results are shown in table III.

TABLE III

Nature of subject	Blood ketone as mg of acetone per 100 c c blood*	
	Behre's method	Somogyi's method
Normal	0 88	0 90
	0 79	0 78
	0 91	0 87
	0 72	0 75
Diabetic	1 13	1 21
	2 88	3 01
	0 902	0 925
	4 51	4 62

M K CHAKRABORTY
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* The table shows that the total acetone content as found by us per 100 c c human blood lies within 1 mg The acetone-content of diabetic blood has not been found by us to be very high (16-20 mg) as by foreign workers This may be due to the less intake of fat by the average Bengalee

[1] Weichselbaum T E & Somogyi M, *J. Biol Chem.*, **140**, 5, 1941
[2] Behre, J A and Benedict, S R, *J. Biol Chem*, **136**, 25, 1940

KETOLYTIC FACTOR IN THE NORMAL PLASMA

RECENT observations by Nath and Brahmachari,[1, 2] have revealed that some keto-compounds which are the intermediary metabolism products of fats are responsible to a great extent for the onset of hyperglycemia in normal animals and can cause inactivation of insulin both *in vivo* as well as *in vitro*.

It is expected therefore that the diabetic plasma is deficient in some principle or factor which might be present in normal plasma and which might directly be effective in bringing about oxidation of acetone bodies by way of direct ketolysis Attempts have therefore been made to make a comparative study of ketolysis brought about by normal and diabetic plasma The effect of amellin, the new type of antidiabetic compound reported by Nath and associates,[3, 4, 5] towards bringing about direct ketolysis (*in vitro*) were also made The estimation was made according to Behre and Benedict[6] as modified by Chakraborty and Nath[7] The results are shown in the following table

TABLE I

SHOWING THE KETOLYTIC EFFECT OF NORMAL PLASMA, DIABETIC PLASMA AND AMELLIN IN THE ALKALINE MEDIUM (5N NaOH) WITH AND WITHOUT H_2O_2

Sodium acetoacetate solution taken, 10 c c = 10 367 mg acetone

Substance used	H_2O_2 (perhydrol) in c c	Acetone in mg after distillation			
		Initially	after		
			1 hr	2 hrs	24 hrs
Nil	10	10 28	9·75	9 18	5 7
Normal plasma	0	8 63	4 07	3 78	3·56
(1 5 c c)	10	8 18	2·10	1 62	1 30
Diabetic plasma	0	10 20	9·60	8 70	8·10
(1 5 c c)	10	9·80	6 70	2·20	1·20
Amellin	0	11 53	11·50	11 40	11·34
(50 mg)	10	9 42	4·31	3 1	1 4

The results indicate very nicely how the normal plasma alone even without H_2O_2 can bring about ketolysis to a considerable extent within 2 hours' time Works of Kohler, Windsor and Hill[8] have shown that neither insulin nor glucose has any appreciable effect on the injected acetoacetic acid in the system. But the above results show that amellin

can bring about ketolysis to the extent of more than 50 per cent within one hour, in presence of H_2O_2, thus accounting for its effect on diabetics in bringing about relief in acidoses and Ketonemia as reported by Nath, Chakraborty and Brahmachari[9] and other symptoms associated with the disease.

Further works are in progress

M. C NATH
A H. M HABIBUL ISLAM

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Dacca University, 28-1-1947

[1] Nath, M C & Brahmachari, H D, *Nature*, *199*, 487, 1944
[2] Nath, M C & Brahmachari, H D, *Nature*, *157*, 336, 1946
[3] Nath, M C, SCIENCE AND CULTURE, 7, 572, 1941-42, *Ann Bio-chem Expt Med*, *3*, 63, 1943
[4] Nath, M C & Banerjee, S R, *Ann Bio-chem Expt Med*, 3, 63, 1943
[5] Nath, M C & Chowdhary, N K, *Ann Bio-chem Expt Med*, *3*, 147, 121, 1943, 5, 11, 1945
[6] Behre, J A & Benedict, S R, *J Bio-Chem*, *70* 487, 1926, *126*, 25, 1940
[7] Chakraborty, M K & Nath, M C, SCIENCE AND CULTURE, (current issue)
[8] Koehler, A E, Windsor, E and Hill, E J, *Biol Chem*, *140*, 811, 1941
[9] Nath, M C, Chakraborty, M K and Brahmachari, H D, *Ann Bio-chem Expt Med*, 5, 101, 1945

CHEMICAL ENGINEERING EDUCATION

I have read with interest an article on "Chemical Engineering Education" by S. K Nandi published in the October issue of the journal It is really an able synopsis of what had appeared in the foreign press about the scope and development of this subject In our country there are at present very few trained chemical engineers and the subject is gradually gaining importance and popularity and as such Mr Nandy's article is very timely published

I am however sorry to find that while mentioning the names of the Institutes where instructions in Chemical Engineering are imparted in India, the author has omitted the Applied Chemistry Department, Calcutta University where the subject had been introduced as early as 1920 by the late Dr H K. Sen, the then Head of the Department and constitutes an important part of the 2-year course for the M.Sc. degree in Applied Chemistry Honours graduates in Chemistry having Physics and Mathematics as subsidiary subjects are only eligible to take up the course of study. Graduates from different Universities in India seek for admission but owing to lack of accommodation have to be reluctantly refused.

It may however be mentioned that the curriculum has of late been adapted according to the recommendations of the Institute of Chemical Engineers, England.

B K MUKHERJEE

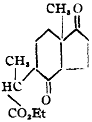
Applied Chemistry Department,
Calcutta University,
30-1-1947

SYNTHETIC INVESTIGATION IN THE ALICYCLIC RING SYSTEM

THESE series of experiments were undertaken with a view to preparing alicyclic intermediates, which may prove valuable for the preparation of perhydro phenanthrene derivatives

At first ethyl β-2-ketocyclo hexyl propionate was subjected to Reformatsky's reaction with ethyl α-bromopropionate, and various products isolated, having different boiling points are as follows: (*i*) ethyl methyl-2-β-carbethoxy-ethyl cyclo hexylidene acetate (b p 164-167°/4 mm, Found, C-67 3%, 67 7%, H-9 08%, 8 7%, $C_{16}H_{26}O_4$ requires C-68 0%, H-9 2%), (*ii*) 1-methyl-2-keto-3-carbethoxy-$\Delta^{1,9}$-octalin (b p 135-137°/4 mm, Found, C-71 1%, H-9 2%, $C_{14}H_{20}O_3$ requires C-71 1%, H-8 5%), (*iii*) 1-methyl-2-keto-$\Delta^{1,9}$ octalin (b.p 125-127°/8 mm, Found, C-80 6%, H-9 8%, $C_{11}H_{16}O$ requires C-80 48%, H-9 7%; Semicarbazone, m p 210° (decomposed), Found, N-18 75%, $C_{12}H_{19}ON_3$ requires, N-19 09%) Similar type of Reformatsky's reaction with ethyl bromo propionate was previously observed by Simonsen *et al*[1] and recently it has found its fruitful application in the synthesis of desoxy testosterone by Mukherjee[2] The above unsaturated β-keto-ester, (*ii*) could be smoothly converted into the unsaturated ketone, (*iii*) by treatment with alkali, the latter in it turn was reduced over Adam's catalyst to 1-methyl-2-ketodecalin, semicarbazone, m.p 192 5°, Found, N-19 2%, $C_{12}H_{21}ON_3$ requires, N-18 8%). Above decalin derivative was prepared by Robinson *et al*[3] from the corresponding hydroxymethyl naphthalene by reduction, followed by oxidation of the alcoholic group, further they converted it into a reduced phenanthrene derivative by condensation with Mannich's base prepared from acetone and formaldhyde. Our synthesis of the methyl decalone was carried out as early with the same end in view.

Attempt is now being made to prepare o 3 4-nonane derivative (I) and the progress made has been described in the following lines



(I)

Sodio salt of ethyl 1, 2-dicyanobutyrate was condensed with β-chloroethyl-methyl ketone. The resulting crude condensation product was hydrolysed by refluxing with concentrated hydrochloric acid and the acidic fraction thus obtained was esterified by the alcohol-sulphuric acid method, when diethyl-α-methyl-α'-γ keto butyl succinate (b p 135°/5 mm., 125-127°/3·5 mm., Found, C-59 9%, H-9 09%; $C_{13}H_{22}O_5$ requires, C-60 4%, H-8 53%) was obtained in moderate yield. Above keto-dicarboxylic ester was condensed with ethyl cyano acetate to yield ethyl-1-cyano-2-methyl Δ^1-heptene-1, 5, 6—tricarboxylate (b p 180-190°/3 5 mm., Found, N-4 13%, $C_{18}H_{27}O_6N$ requires N-3 96%). One mole of hydrocyanic acid was added to the unsaturated cyano ester and the crude dicyano ester obtained therefrom, was hydrolysed and esterified to give ethyl-2 methyl heptane-1, 2, 5, 6 tetra carboxylate (b p 192-195°/3 mm., Found C-58 98%, H-7 7%, $C_{20}H_{34}O_8$ requires C-59 7%, H-8 45%). On cyclisation of the above tetracarboxylic ester by refluxing sodium dust in dry benzene solution, the β-keto ester, which gave positive ferric reaction, was found to decompose on attempt at distillation under diminished pressure.

The sodio or potassio derivative of the above β-keto ester is intended to be condensed with ethyl β-chloro propionate and then proceeding through usual series of reaction (I) is expected to be obtained.

Our thanks are due to Prof. P C Mitter and Prof. S N. Bose for the interest they have taken during the progress of this work. One of us (P D) is grateful to Adair, Dutt Research Fund Committee for the grant of a scholarship.

PRANBANDHU DUTT
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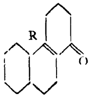
[1] *J. C. S.*, 1576, 1937.
[2] SCIENCE AND CULTURE, *11*, 474, 1945-46
[3] *J. C. S.*, 386, 1941.

SYNTHESIS OF 1-KETO-13-METHYL-Δ^{11}-DODECAHYDROPHENANTHRENE

In view of the recent publication on the synthesis of 1-keto-$\Delta^{4a,10a}$-dodecahydrophenanthrene (I, b) by Bachmann and Wendler[1], with the avowed intention of preparing (I, a), we desire to place on record the following experiments carried out in this connection.



I, a – R = CH_3
I, b – R = H

Cis-9-Methyl-1-decalone was reacted with the Grignard complex prepared from γ-ethoxypropylbromide to yield 9-methyl-1-hydroxy-1-γ-ethoxypropyldecalin (b p 174°-180° 13-14 mm.). The above hydroxy-ether was heated with acetic acid saturated with hydrobromic acid and a small quantity of acetic anhydride in a sealed tube at 90° and the crude dibromo compound obtained therefrom was digested with aqueous potassium cyanide in acetone solution, and the resulting product was also hydrolysed in the crude state by prolonged refluxing with methyl alcoholic caustic potash. The acidic product isolated in the usual way boiled at 174° 3 5-4 mm. and its analytical data corresponded with that of 9-methyl-1-γ-carboxypropyl-octalin-1 (Found, C-76 6%, H-9 7%; $C_{15}H_{24}O_2$ requires, C-76 3%, H-10 1). Above unsaturated acid was converted into its acid chloride with thionyl chloride and pyridine and was treated in the cold with stannic chloride in carbon bisulphide solution and the crude chloroketone was heated with dimethylaniline at 180°-190° for 3 hours. The resulting product, b p 145°/4·5-5 mm. on being tested for chlorine and as well as from analytical data showed that only partial unsaturation had taken place (Found, C-77·4%, H-9 3%, $C_{15}H_{22}O$ requires, C-82 6%, H-10 2% and $C_{15}H_{23}OCl$ requires, C-70·7%, H-9 0%). It was then distilled in the vacuum over solid caustic potash, when the desired product (I, a) was obtained in the pure state (Found, C-82·5%, H-10 1%; $C_{15}H_{22}O$ requires, C-82·6%, H-10·2%).

My thanks are due to Prof. P. C. Mitter for the interest he has taken during the progress of this

work and also to Mr N Ghosh, M Sc for carrying out micro-analysis of some of the compounds

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[1] Bachmann and Wendler, *J Am Chem Soc*, 68, 2580, 1946

SCIENCE AND INDUSTRIAL PRODUCTION

"I have read with interest the Editorial in SCIENCE AND CULTURE, March, 1947. I regret very much to note that the technical personnel of the Mathematical Instruments Office which jumped to 2115 from the pre-war figure of 341 are now being very rapidly retrenched and the hope of expanding the Mathematical Instruments Office into a large Scientific Instrument concern under the aegis of Government are being shattered under the very nose of the first National Government I wish you had referred in this connection to the following quotation from Bernal's "The Social Function of Science" (page 227) —

'The detailed carrying on of scientific work, apparatus, laboratories, etc does not differ fundamentally in the Soviet Union from that outside it There is an interesting development, however, in the *production of apparatus*, which instead of being left to individual firms, with resultant high prices and small turnover, *is centred in the institutes themselves*, which permits a rationalization of production and a consequent cheapening and multiplying of scientific apparatus so that in nearly every field the Soviet Union has become independent of foreign apparatus, a feat which is all the more remarkable in that there was practically no scientific apparatus made in the country before the Revolution '

The Russian experience shows what can be done when there is the will to do it I do hope that this editorial would be brought to the attention of the Department of Government which is responsible for developing our key industries and also to the Department of Government which is responsible for the management of the Mathematical Instruments Office in Calcutta"

J C GHOSH

Bangalore, 18-3-1947

Engineering and Metallurgy

Engineering Education, Research and Power Development

H. P. BHAUMIK

ENGINEERS will have to play a big part in Post-War development in India under the new National Government. In view of the paucity of qualified Engineers in the country the training of Engineering personnel, expansion of Engineering Colleges and creation of new Higher Technical Institutions are urgently called for. Planning of industries and training of Engineers and Technicians must proceed more or less simultaneously.

Engineering research has been totally neglected in this country in the past and we have been made to depend on other countries in this respect unlike research in fundamental science in the Universities, which has brought distinction to many Indian scientists. The time has now come for creating immediately organizations for research in the various branches of Engineering.

Standard specifications for Engineering materials and practice should be drawn up keeping in view the maximum utilization of raw materials available in the country and their suitability for being used easily in the conditions prevailing in the country.

The generation of electrical energy, without which no modern industry can grow, is of first rate importance. All available statistics show that India lags far behind other countries in production of electrical energy. Her potentialities in this respect are, however, very great. The country seems to have awakened to this immediate need as shown by the interest created by Multi-purpose Damodar Valley scheme. Thermal plants for production of electric energy by utilizing low grade coal should also be installed along with hydro-electric plants. It is of vital importance that industries should be decentralized as far as practicable so that the rural areas may benefit socially and economically. Cheap electricity can alone make this possible on a large scale through a system of distribution by inter-connected grids.

The development of Tele-communication in India after World War I had not been as fast as one would have desired on account of extreme caution and absence of definite planning. The Baudot printing telegraph system held the field first and later Teleprinters have replaced the Baudot apparatus. Auxiliary appliances were manufactured in the Telegraph workshops in Calcutta by skilled Indian workmen with such success that imports of such apparatus from France and England were entirely stopped.

Considerable expansion of Tele-communication in India has been achieved under pressure of World War II, in fact the assets of the Department have almost become double in the course of 2 or 3 years. It is to be noted that for the first time schemes were executed without detailed profit and loss calculation by way of financial justification which unnecessarily held up any scheme of expansion in the past although Tele-communications should have been treated as a public utility and not a commercial concern.

The serious drawback of having to depend on foreign countries for plant and apparatus must be remedied immediately and the existing workshops of the Telegraph Department at Calcutta, Jubbulpur and Bombay should be fully utilized and developed for the purpose. The argument that it will be more economical for India to import apparatus from abroad is wrong. Her workmen have already proved their capacity by successfully manufacturing complicated apparatus like Baudot, Manual Telephone and Trunk Exchanges etc. in the Telegraph workshops. Nor will her need for such apparatus be small as assumed. It has been proposed that the main workshop of the Department should be located at Jubbulpore. The place however is most unsuitable for a workshop which will manufacture equipment on a large scale.

A research branch with a laboratory should be immediately organized for the Department on the lines of the Dollis-Hill laboratory of the British Post Office.

Chemistry

Plastics

P. K. Bose

THE address is a brief survey of the various developments in synthetic resins Basic chemical reactions involved, as far as these are known, have been touched upon for most of the well-known or recently developed important groups, such as phenol-formaldehyde resins, amino-plastics, polyethylenes and polystyrenes, coumarone and indene resins, acrylic and vinyl resins, cellulose derivatives, alkyd resins, protein plastics, nylons, silicones etc Their chief uses and where possible, their production-statistics have also been given Many war-time developments including new formulation, *e g*, tetrafluoroethylene, allyl resins, *isocyanate* resins, polyvinyl carbazoles, discovery of new uses and evolution of new technique, *e g*, high speed plunger moulding, foam-plastics, "heatronic" heating, low and contact pressure lamination etc shrouded in secrecy till now, many of which are of a very remarkable nature, have also been included As a necessary counterpart to the purely chemical side, a section has been devoted to a short review of the salient findings of physical and physico-chemical studies which have led to a more or less clear recognition of the fundamental principles underlying the formation of these polymers and served to correlate their physical and chemical properties with the chemical structure of the basic units and their aggregated complex. Particular mention has been made of the discovery of Nylon which illustrates in a striking way a triumphant application of these theoretical principle The address also includes a brief reference to the research work on shellac and plastics done in India, and while emphasising the need for indigenous plastics industries, offers certain concrete suggestions towards the fulfilment of that need with due regard to the present availability of raw materials in India It suggests incidentally where in view of the peculiar raw-material position of India, departure from western methods would be permissible The need for reorganisation of coal-tar industries on sound rational lines has been stressed and plea for a Central Plastics Research Institute with clearly assigned functions advanced

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Agricultural Sciences

Sugarcane in India—A Retrospect and Prospect

N. L. Dutt

THE varieties of sugarcane grown in India in the 18th and 19th centuries have been listed by Watt (1893) in his Dictionary of Economic Products of India. He did not attempt to classify the indigenous Indian canes as he found them to be very diversified. The thicker class of canes allied to Mauritius canes must have existed in India earlier as Ibn-i-Batuta who travelled in India in the 13th century makes mention of the *Paunda* cane of Malabar coast. There are references in Dravidian literature of the *Sangam* period before 2nd century A.D. pertaining to sugarcane thus affording knowledge of sugarcane (probably thick canes) in South India at quite an early period. The references in the Sanskrit literature, *viz.*, *Atharva Veda*, the Institutes of Manu, etc., pertain, no doubt, to the North Indian indigenous canes.

The first attempt to classify the indigenous canes was made by Hadi (1902) for the U. P canes His classification is not strictly scientific. Woodhouse and Basu (1915) studied the Bihar canes and proposed a scientific classification. In the meanwhile the indigenous canes from several parts of India were being very comprehensively studied by Barber at Coimbatore and he published his classification (1916) which is now the standard classification of the Indian canes. Jeswiet (1916 and 1925) gave the Indian canes the

rank of a separate species, *viz*, *Saccharum Barberi*, Jesw. The *Pansahi* group of Barber was transferred to *Saccharum sinense*. This is an amendment of the original *S. sinensis* of Roxburgh.

The studies of the writer and J. Thuljaram Rao on *Erianthus* reveal that it should be separated from *Saccharum* and such forms as *S. munja* and *S. arundinaceum* should be removed from *Saccharum* and placed under *Erianthus*. There are three distinct groups in *Erianthus* itself. Some of the characters of *S. officinarum* are found in *Erianthus* to the exclusion of other species of *Saccharum* thus indicating the probable origin of *S. Officinarum* from *Erianthus*. Grassl (1946) working in America thinks that *S. officinarum* would appear to be related to *S. robustum* and *Erianthus maximus*. As regards the Indian canes, Barber was of the view that at least some of the primitive canes of that species resembled *S. spontaneum*. Parthasarathy from his cytological studies is of the view that the indigenous Indian canes might have evolved from an extensive hybridization between *S. officinarum* and *S. spontaneum*.

The indigenous Indian canes mentioned by Watt continued to hold the field in all the North Indian tracts till the release of the Co. canes from the Coimbatore Station in 1918. Nearly eighty per cent of the area under sugarcane in India is in North India, the area in U. P. accounting for a little over 50 per cent of the entire area under cane in India. The renaissance of the sugar industry dates from 1932 when the protection to the sugar industry was granted by the Government of India. The Co canes now occupy 80 per cent of the area under cane in all the major cane growing tracts in India and have increased the yield of cane per acre by 50 per cent. A proper cane development programme as envisaged by the author would bridge the gap between the yields at the sugarcane stations and those realised by the average cane grower in his fields. It is suggested that a sum of Rs. 2 crores should be spent every year on cane development alone for the period of the next ten years before the desired object of the stabilization of the sugar industry will be in sight as the bulk of the cost of sugar production is represented by the price paid for raw material. Details have also been suggested regarding the place that the early, mid-season and late varieties as also the ratoon should occupy in the planned cane growing of the immediate future.

Zoology and Entomology

Applied Helminthology, its Past and Future in India

G. D. BHALERAO

DR BHALERAO gave a very comprehensive and concise account of the work done in India in the field of applied helminthology from ancient times to the present day and indicated the lines on which future development should take place.

While dealing with flukes Dr Bhalerao observes that the commonest liver-fluke in India is *Fasciola gigantica* and its intermediaries are *Limnaea acuminata* and *L. luteola*. Liver-fluke disease causes more mortality in cattle in India than any other disease. Carbon tetrachloride has been recommended for the treatment of all ruminants on account of its cheapness despite its toxicity to cattle for a couple of days. From his own experience the author recommends removal of water weeds, at least twice a year, as an efficient means of controlling snails. Mention has been made of the intermediaries of other liver-flukes in India and suggestion has been offered in regard to the vector of *Eurytrema pancreaticum*. Chief among the intestinal flukes are *Fasciolopsis buski*, *Fasyphostomum sufrartyfex* and *Gastrodiscoides hominis*. These flukes being common to pigs and men it will have to be determined whether these two hosts harbour different biological strains of these parasites like *Ascaris lumbricoides*. First record has been made of cercarial dermatitis occurring in India in the Mysore state. While reviewing blood-flukes the author comprehends the possibility of *Schistosoma haematobium* establishing itself in India as is postulated by de Mello in Portugese Goa. The blood-fluke of the elephant is stated to belong to the genus *Ornithobilharzia* and not to *Schistosoma*. Immature forms of *Cotylophoron* spp. and *Gastrothylax crumenifer* are stated to produce the condition known as "Gillar", "Pitto" or "Bisi" in India. The author proved experimentally that *Cercariae*

indicæ XXVI is the larval stage of *Cotylophoron cotylophorum*

Dealing with tapeworms reference has been made to *Tænia solium* and its larval form *Cysticercus cellulosæ, T. saginata, Bertiella studeri, Hymenolepis nana* and the Hydatid Carbon tetrachloride is stated to be a better drug than tetrachlorethylene in the treatment of tæniasis of men It was surprizing to find 20 per cent of Hindu coolies at Mukteswar infected with *T saginata* (the beef tapeword) The author has been the first to note the location of *Cysticercus bovis* in the liver All cases of human infection with *B studeri* have been known only in children, adults being immune Gentian violet has been stated to be very effective in eliminating *Hymenolepis nana*. Hydatid disease appears to be more common in India than the available records show In some localities 70 per cent of cattle are infected with Hydatid cysts and 90 per cent of them are sterile.

Of the intestinal nematodes of men and animals reference has been made to the species of the genera *Ascaris, Ascaridia, Toxocara, Heterakis, Enterobius, strongyloides, Ancylostoma, Necator, Bunostomum, Oesophagostomum* and *Trichinella* *Ascaris lumbricoides* may produce in man symptoms simulating cerebral malaria. It is remarked that no true cure exists for *Enterobius vermicularis* Gentian violet is stated to be very effective against *Strongyloides stercoralis* The control of hetrakid worms of poultry is a highly economic problem since they act as the carriers of *Histomonas meleagridis* which produce "Black-head" in turkeys and fowls In some localities in India 5 to 10 per cent of young chicks succumb to black-head Of the hook-worms of man *Necator americanus* are stated to be more common than *Ancylostoma duodenale* Tetrachlorethylene is the drug of choice against hookworms To control the disease people who have no conservancy convenience should be encouraged to defecate on slopes and the cockroaches should not be allowed to be devoured by rats and mice as the former feed upon hookworm infected fæces Natural cases of "Creeping Eruptions" caused by hookworm larvæ appear to be non-existant in India. Hook worms of domestic ruminants are the species of *Bunostomum*. They cause much loss to the wool industry Nodular worms, however, affect the sausage and cat gut industry Phenothiazine acts as both curative and prophylactic against hookworms and nodular worms of ruminants Bronchial worms fall into the genera *Dictyocaulus, Protostrongylus* and *Varestrongylus* The last one was discovered by the author in 1932 and since then it has been known to occur in China and America Recently the author has found that the land-snail, *Macrochlays cassida*, acts as its intermediary An effective treatment for the bronchial worms remains yet to be discovered Reference has also been made to the kidney worm and the eye worms Elephantiasis has been known to occur in India from very early times The "*Parisarpa*" of *Sushruta* is referable to the microfilaræ in the blood Elephantiasis in India is caused by two species of worms, *viz*, *Wuchereria bancrofti* and *W malayi* In some localities the infection may be as high as 20 per cent After extensive trials Chopra found "Soamin" as the most satisfactory in controlling the disease in early stages Mosquitoes of the genera *Culex* and *Anopheles* carry *W bancrofti* and those of *Mansonoides* and *Anopheles* carry *W malayi* In addition to man the Guinea-worm affects dogs and horses Valuable information has been added to the knowledge of this worm by Moorthy who for the first time described the male adequately

Dr Bhalerao pointed out how varied and numerous are the problems in applied helminthology and how colossal is the economic loss suffered by India on account of the ravages of worm parasites. Finally he commends it to the authorities, with whom lies the task of shaping the destiny of future India, to create adequate facilities for the study of this important branch of science, which vitally concerns the welfare of India and to his young colleagues in India he exhorts to take up seriously the study of helminthology in all its aspects

Indian Science News Association

ELEVENTH ANNUAL REPORT

THE Council of the Indian Science News Association have much pleasure in submitting this, the Eleventh Annual Report and the Statement of Accounts for the period July 1, 1945 to June 30, 1946

OBITUARY

During the year under review, death has removed from among us Sir U N Brahmachari who was intimately associated with the Association and its journal from their very inception It may be recalled that the Indian Science News Association came into existence in 1935, with a gift of Rs 1,000/- from Sir U N Brahmachari, and his patronage to the Association never lacked in warmth and spontaneity He made further gift to the extent of Rs 1,500 and served the Association as its President from 1944 till his death In his death, Indian science as a whole has sustained an irreparable loss Recently we have lost another of our distinguished members in the person of Prof P N Ghosh who was always an enthusiastic supporter and admirer of "Science and Culture". Not only did he enrich the pages of our past volumes with a series of learned articles on scientific subjects in which he was an authority, but he also served the Association in the official capacities of Vice-President He also officiated as President immediately after the death of Sir U N Brahmachari, and it is our great misfortune that we had also to lose him soon after.

MEMBERSHIP

During the year 1945-46 there was an addition of one life-member making the total 112 The number of ordinary members showed an increase of 5 over that of the last year which was 52

SCIENCE AND CULTURE

Our journal continued to maintain its high standard in scientific journalism relating to both its articles and editorials besides in other respects. Many of our articles have been abstracted in foreign journals and some of the accounts of investigation published in the Letter's to the Editor section have been referred to in papers of foreign scientists. We take this opportunity of expressing our thanks to those specialists in foreign countries who contributed articles to our journal and readily collaborated with the Editorial Board

The total number of copies despatched in June 1946 was 1497 as compared to 1385 in the same month of 1945. The number of subscribers in June 1946 including the members of the Association was 1335 showing an increase of 147 We had to strike off 10 subscribers from the list Of these 5 discontinued, 2 were removed by death, and 3 for defaulting. The actual number of new subscribers enrolled was 131.

EXCHANGE JOURNALS

The total number of copies of the journal sent out every month in exchange and for review was 80 We received in exchange 30 Indian and 25 foreign journals We also received journals of learned societies and publications of Government Scientific Departments Several Calcutta newspapers, supply their daily issues in exchange as before as well as the well known Madras daily, *The Hindu*. Like past years we send the journal regularly to several Societies and Institutions on request

ADAIR, DUTT RESEARCH FUND

We are glad to announce that the well known firm of Messrs Adair Dutt & Co. Ltd , dealing with scientific instruments, has placed at our disposal a further sum of Rs. 5,000/- for award of research scholarships The following scholars, at present engaged on research work, are paid from this fund.

(1) Mr P. Nandi—Micro-biology (Now in England)
(2) Mr Pranbandhu Dutt—Chemistry
(3) Mr Asok Kumar Kar—Botany.

(*For Statement of Accounts, see last page*).

GRANTS

We are grateful to the authorities of the University of Calcutta, the Bengal Chemical & Pharmaceutical Works, Ltd., and the Indian Association for the Cultivation of Science for renewing their annual grants. The amounts of these grants are as follows.—

Calcutta University	Rs. 500/-
Bengal Chemical & Pharmaceutical Works Ltd.	,, 500/-
Indian Association for the Cultivation of Science	,, 100/-

During the year the Association was fortunate enough to receive a donation of Rs. 850/- from the National Institute of Sciences of India, for which we express our sincerest thanks to the authorities of the Institute.

Our thanks are also due to the authorities of the Calcutta University for accommodating the office of "Science and Culture" in the University Science College building.

The recent visit of Dr Harlow Shapley, Director of the Harvard College Observatory to our Association also deserves mention here He delivered an address in a meeting of scientists, held under the auspices of the Association, on American science, science news service, and various other academic activities in America

The journal would be completing its twelfth year of existence this June We are now passing through a very critical period of our national existence The arrival of the Cabinet Mission, their far-reaching constitutional proposals, the formation of the Interim Government, the setting up of the Constituent Assembly, and, the last but not the least, the sudden explosion of the communal violence in the series of riots which threw the entire country from Bombay to Bengal into a terrible convulsion and in which thousands perished for no fault of theirs, have made the prospects of peaceful activities in the cultivation of arts and sciences, or in the dissemination of scientific information and culture, recede temporarily at least, into the background During such troublesome times, it was with great difficulty that we managed to maintain the normal functions of this Association The publication of the journal was for a time delayed, which, thanks to the co-operative efforts of the staff, the press and all those who have loved and laboured for it, has been restored to its normal order. The dislocation and chaos in trade and commerce of the city, consequent upon the riots, have adversely affected our business, and the Association has been faced with unprecedented financial crisis All these are indeed temporary phases, and we hope for an early recovery from all these evil effects through the active co-operation of thousands of our readers, subscribers, members, and advertisers and all who have contributed to the building up of this great national organ, so that we may continue to serve them and our country for years to come.

Our thanks are due to the numerous honorary workers who month after month helped the journal with contributions and suggestions and also to the permanent staff of the office who have ungrudgingly shouldered the heavy burden of maintaining the tradition and reputation of the journal in the midst of trying times. The war-years and particularly the past two years have put us to great financial difficulties owing to a rocket-like rise in the printing cost Thanks are due to Mr A P Benthal and Mr F. W. Goss of the Titaghur Paper Mills for their kindly supplying us a special quality of paper for the journal, so very necessary for good reproduction of illustrations and figures in the articles. Though for this special brand of paper we had to pay only a slightly higher rate, the actual cost of printing, however, has gone up by 250 per cent over that of 1939. It is really gratifying to note that we have enrolled a large number of subscribers during these years and also the number of advertisers has increased. Up till now we have not increased the advertisement tariff commensurate with the increased cost of production and the larger circulation the journal enjoys

We have received suggestions of reviewing the whole position and reshaping the journal to make it more attractive to the ordinary men Naturally this will involve extra cost, and we think we shall not be misunderstood if we try to meet it by raising the subscription rate in proportion to the cost of production and also by increasing the advertisement tariff

Looking back into these past eleven years we feel proud of the fact that we have been able by means of our journal to rouse the public opinion for a higher standard of living, which can only be possible by the utilization of science for social ends and by scientific development of our natural resources The whole country is passing through a very hard and critical time of transition and it is a good augury that the leaders of public life are now in close touch with the scientists and are not unmindful of integrating science with the administrative machinery of the country We believe that now is the time for restressing our views and for raising the journal to a more useful level, for which we look forward to your continued sympathy and co-operation.

We hope to be excused for not being able to hold the regular Annual General Meeting this year as usual due to many abnormal conditions in the country and particularly in the city of Calcutta.

(*For Statement of Accounts, see last page*)

The following is the list of office bearers and members elected for the period 1946-47

President—Prof. D N Wadia

Vice-Presidents—Dr S. C Law, Dr Baini Prashad, Prof M N. Saha, Dr W. D. West, Sir S S Bhatnagar, Mr G. L. Mehta and Prof S K. Mitra

Treasurer—Prof. P C Mitter.

Secretaries—Prof. P. Ray, Dr D. M. Bose

Members.—Prof S. P. Agharkar, Dr B. Ahmad, Mr H. P. Bhaumik, Dr B C. Guha, Dr K. Biswas, Mr N. R. Sarker, Col. Sir R. N. Chopra, Dr M. S. Krishnan, Sir J. C. Ghosh, Dr D S. Kothari, Mr B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Dr J. N. Mukherjee, Hon'ble Dr John Matthai, Mr M. M. Sur, Dr S. L. Hora and Dr A. C. Ukil.

INDIAN SCIENCE NEWS ASSOCIATION

(REGISTERED UNDER ACT XXI OF 1860)

Receipts and Payments Account for the Year ended 30th June, 1946.

RECEIPTS

	Rs. As. P.	Rs. As. P.
To *Opening Balance on 1-7-45* —		
(*a*) At Bengal Central Bank Ltd. in Savings A/c.	1,738 9 9	
(*b*) At Bengal Central Bank Ltd. in Current A/c.	3,059 4 6	
(*c*) With Treasurer	89 3 6	
		4,887 1 9
Grant		1,100 0 0
Donation		850 0 0
Donation Re Adair Dutt Research Fund		5,000 0 0
Life Membership Fee		781 0 0
Ordinary Membership Fee		403 0 0
Subscription		5,739 2 9
Advertisement		8,341 15 9
Reprint		693 8 0
Miscellaneous		1,059 15 9
Interest —		
On 3½% G. P. Note	122 1 5	
On Banking Account	24 9 0	
		146 10 5
		Rs. 29,002 6 5

PAYMENTS

	Rs. As. P.	Rs. As. P.
By Establishment		5,890 0 0
Journal Printing ...		7,441 7 9
Paper ..		6,403 14 6
Postage & Receipt Stamp		961 0 0
Conveyance & Travelling		290 7 0
Telephone		271 8 0
Miscellaneous		263 13 3
Audit Fee (re: 1944-45)		60 0 0
Stationery & Printing		241 13 6
Bank Charges		51 11 6
Binding Charges		59 0 0
Adair Dutt Research Fund		5,050 0 0
Commission		121 11 0
Furniture		115 7 6
Closing Balances on 30-6-46 —		
(*a*) At Bengal Central Bank Ltd. in Savings A/c	1,286 3 10	
(*b*) At Bengal Central Bank Ltd. in Current A/c	388 14 10	
(*c*) With Treasurer	105 5 9	
		1,780 8 5
		Rs. 29,002 6 5

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of the INDIAN SCIENCE NEWS ASSOCIATION (Registered under Act XXI of 1860) for the year ended 30th June, 1946, with the books and vouchers and have obtained all the information and explanations I have required. I certify that the the said account is correctly stated in accordance with the books of accounts of the Association.

6, Old Post Office Street,
Calcutta, the 11th September, 1946

A. K. GHOSH,
Government Diplomaed Accountant
Registered Accountant,
Auditor.

P. RAY,
Honorary Secretary,
Indian Science News Association

D. M. BOSE,
Honorary Secretary,
Indian Science News Association

P. C. MITTER,
Honorary Treasurer,
Indian Science News Association

ADAIR, DUTT RESEARCH FUND

Receipts and Payments Account for the Year ended 30th June, 1946.

RECEIPTS

	Rs. As. P.	Rs. As. P.
To *Opening Balances on 1-7-45* —		
(*a*) At Bengal Central Bank Ltd. in Savings A/c	10,359 4 7	
(*b*) With Treasurer	165 15 0	
		10,525 3 7
Indian Science News Assn.		5,000 0 0
Bank Interest		126 2 2
		Rs. 15,651 5 9

PAYMENTS

	Rs. As. P.	Rs. As. P.
By Stipend		4,950 0 0
Establishment		200 0 0
Accountancy Charges		15 0 0
Contingency & Conveyance		1 11 0
Closing Balances on 30-6-46 .—		
(*a*) At Bengal Central Bank Ltd. in Savings A/c	10,220 2 9	
(*b*) With Treasurer	264 4 0	
		10,484 6 9
		Rs. 15,651 5 9

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of ADAIR, DUTT RESEARCH FUND for the year ended 30th June, 1946, with the books and vouchers and have obtained all the information and explanations I have required. I certify that the said account is correctly stated in accordance with the books of accounts of the Fund.

6, Old Post Office Street,
Calcutta, the 11th September, 1946.

For Adair, Dutt Research Fund.

P. RAY,
Secretary.

G. BHATTACHARYA,
Treasurer.

A. K. GHOSH,
Government Diplomaed Accountant
Registered Accountant,
Auditor.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. MAY, 1947 No. 11

COAL PROBLEM IN INDIA

THE Government of India appointed a Coalfields' Committee* in December, 1945, with Mr K C Mahindra, lately Head of the India Supply Mission at Washington D C, as Chairman This is the fourth of the Coal Committees appointed since 1920 The terms of reference were·

'(1) To review the recommendations made by the various Committees dealing with the problems of the coal industry which were set up by Government from time to time, and to consider—

(a) which of these recommendations have been adopted and with what measure of success, and

(b) what further action needs to be taken by Government in respect of the recommendations which have not been adopted or which have been adopted only in part

(2) To consider and to report what further economic and administrative measures are necessary to deal with the problems of the industry of a non-technical character and, in particular, to report on the conservation of high grade metallurgical and steam coal, the problem of fragmentation of colliery holdings, the opening of new fields, the economics of the coal industry and the stabilization of coal prices '

The terms of reference of the Committee were severely restricted, for it was asked categorically *not* to deal with technical or labour problems. The Committee felt these restrictions rather severely and pointed out in specific terms to the inconsistency in their terms of reference, as without an examination of the technical and labour problems, it could not deal effectively with the task assigned to it, and *had, therefore, at times to transgress the orders of the Government* The Committee says

"The first limitation which, in our opinion, exists on the scope of the present enquiry is the exclusion of consideration of the technical problems of the industry The re-organization of the Indian coal industry and in particular the very considerable increase in production which seems necessary inevitably raise many technical issues and it may be that the Government will, in near future, find it necessary to appoint a Technical Committee to make a proper investigation of these issues In this category would fall questions such as the opening of new collieries, the most suitable methods of working, including the question of mechanization, the adequacy of lighting and ventilation arrangements in mines in view of their bearing on the output of coal per man shift, the suitability of the present Mining Regulations, etc Some of these matters have, however, had to be dealt with by us but from the nature of things, our recommendations can be broad indicators only towards further study "

The reader may rightly ask—"Why does the Government believe in such half measures, instead of going to the root of the problem?" Probably this has been characteristic of the late Government of India, but would the National Government continue to follow in the same old ruts?

WHAT IS THE COAL PROBLEM?

The common reader will like to know what is this coal problem? He is not accustomed to take interest in coal, unless its market price goes up inconveniently, or it is unavailable at times ; in the later case,

* The members of the Committee were —Mr C. A Innes, Partner, Messrs Andrew Yule & Co, Ltd , Mr K C Neogy, M L A (Central), Mr M Ikramullah, I C S, Joint Secretary to the Government of India, Supply Department; Rai Bahadur Lala Raj Kunwar, Chief Minister, Patna State (Eastern State Agency); and Mr P R Nayak, M B E, I.C S, Deputy Secretary to the Government of India, Supply Department (Secretary) The Committee was assisted in technical matters by Mr J R Harrison, C I E, Deputy Coal Commissioner (Production), Mr W Kirby, C I E, Chief Inspector of Mines in India, Khan Bahadur G Faruque, O.B.E., Deputy Coal Commissioner (Distribution), and Mr K. C Mahindra, lately Head of the India Supply Mission, Washington (Chairman). It is to be noticed that no scientist or technician proper, conversant with the modern methods of processing of coal, were attached to the Committee.

Messrs. Neogi and Ikramullah were not available most of the time, and R B Raj Kunwar's appointment was gazetted late So practically it was a three man Committee of Messrs Mahindra, Innes and Nayak.

inhabitants of most cities will have to go on half meals or no meals as it has very often happened during recent times in Calcutta and other Indian cities But coal is more important than mere restriction in domestic use would suggest It is no exaggeration to say that the car of present technical age is mainly drawn by coal.

The importance of the coal problem was brought home in a very vivid manner in England, when, due to persistent shortage in coal production owing to a number of causes, civilian and industrial life in England was almost completely paralyzed for two weeks at the end of February, 1947 The cities of England had to go without electricity, industries had to be closed, and railway transport had to be severely curtailed, and the crisis nearly led to a fall of the Labour Ministry In India, it may not be realized, coal plays an equally important part inspite of the fact that 90 per cent of the people still have to follow fifteenth century economy Stoppage of coal supply will paralyze railway and steamer transport, stop industries, not to speak of indescribable suffering which citizens of big cities will have to undergo

Possibly many political problems which are at present disturbing Indian political life and leading to riots may find their solution, if the legal jugglers who are carrying on these agitations agree to call up a truce for a little while and sit down to think as to how they can arrange for supply for coal essential for the industries and for transport in their respective areas if the ideas and slogans they are swearing by are really given effect to This will blow away many chimeras and illusions

The per capita annual consumption of coal may be taken as a sure index of the 'Industrial Position' of the country. This is 075 ton for India, 4 tons for Britain, and 4 8 tons for U S A , in other words, the average Britisher consumes 52 times and the American 60 times as much as coal as the average Indian This does not mean that the individual citizen uses so much more coal for his private purpose Coal supplies most of the motive power for industries and transport, and the consumption of coal is an index of industrial power of the country If India is ever to walk out of the medieval gutter of poverty and backwardness, she must have a coal policy, including programmes for increasing her coal production steadily but surely for organization of her industries and by making the best use of the coal produced

The Mahindra Committee estimates that the coal production of India should be raised to about 39 to 41 million tons by 1956, the present figure being barely 29 million tons, but they have scarcely indicated how this is to be done Moreover, the Committee appears to be extremely modest in their plans, but how is their plan to be reconciled with the opinions of some members of the Interim Government, who talk of forced march to complete industrialization? What the Committee proposes is not forced march, but a three legged march of capitalism and socialism locked up in lovely embrace!

Long term policy The Committee has also touched the questions of long term policy. These cover survey of coal resources, problems of mining and utilization, and question of substitutes for coal. We touch these in the barest details

Survey Committees and public men since 1932 have quoted the same figures, about coal reserves in India *viz*, the figures of coal survey published by Sir Cyril S Fox in the *Memoirs of the Geological Survey of India*, Vol LIX These figures are admittedly rough, and take account of coal reserves up to 2,000 ft only from surface, while coal mining has been carried out to depths of 5,000 ft in other countries Further, the present surveys are mostly based on the existence of outcrops. But it is well known that valuable coal deposits may be hidden by a small overburden of alluvia, and rocks, and only chance findings* or prospecting by modern geophysical methods may reveal their existence It is very desirable that the Geological Survey of India should have a strong section devoted exclusively to a proper survey of coal deposits, as the Department of Scientific and Industrial Research has done for the United Kingdom, and latest methods of prospecting should be introduced

Methods of Mining There is too much wastage of coal in mining as practised in India, and in fires in coal mines which are not extinguished These have been dealt with in several articles in SCIENCE AND CULTURE Legislative measures ought to be taken to remedy this hydraheaded evil

Utilization of Coal Several writers in SCIENCE AND CULTURE have pointed out to the aweful wastage of coal in its processes of utilization To give a few examples to produce a unit of electrical energy, the best British power stations have to burn ·9 lbs., and the average is about 1 2 lbs whereas the average consumption in India is 2 5 lbs or more The electric supply companies in India use anti-dated methods of combustion, but the railways are the largest sinners in this respect, followed by the domestic consumer and, to a lesser extent, by the industrialists. In fact, if we introduce modern machinery and modern methods of combustion, we can have the same service from half the amount of coal now used †

* Only a few years ago, an extensive and apparently rich coal field in the C P was discovered at a depth of 120 ft when a tube-well was being sunk at Kamptee, a suburb of Nagpur The Russians have discovered extensive coal fields in Siberia beneath alluvia and layers of snow by the use of geophysical methods (The Kutzenesk Basin)

†As an illustration of wastage of coal, we may refer to the working of the Talah Station of the Calcutta Corporation, which the writer of this article had to visit as member

As coal is a perishable, but irreplaceable, commodity, and India's coal resources are none too plentiful, the economic and scientific use of coal is a matter of national concern and should not be left in private hands. We should have in this country a Bureau of Mines as in the U S A, which, amongst other activities, should deal with the question of utilization of coal in a scientific manner. We understand that the Fuel Research Laboratory at Dhanbad has got this on its research programme. In one of their latest bulletins from the laboratory of the Bureau of Mines, Colorado, U S A, it is reported that, by using very finely pulverized coal, and freeing it from all undesirable impurities, and feeding such coal to furnaces mechanically very much in the same way as liquid fuel is fed in internal combustion engines, the efficiency has been so considerably increased that it is possible to cut down the consumption of coal in railway engines by about 50 per cent.

Need for more radical measures

The question of supply of fuel and power is so vital for general welfare that almost all great countries have now a special ministry devoted solely to fuel and power for formulation and execution of policy and a section of their State Planning Commission or equivalent bodies devoted to continuous planning in fuel and power. As matters now stand, coal is the most important source of fuel and power, almost all over the world, except such countries like Switzerland, Norway, Sweden and a few others which, owing to almost complete absence of coal, have been compelled to gear their requirements to the development of hydro-electric power. If the survey of the coal resources carried out by the G S I is even remotely correct, we have a very gloomy situation before us; even during the present extremely backward state of our industrial development, our resources are being rapidly depleted in certain directions, *e g*, in coal required for metallurgical purposes. But when the scheme of industrialization is in full swing, say when the per capita annual consumption is increased six times, the rate of depletion will be so rapid that future generations will have to depend entirely on other sources of fuel and power. A vital item like 'Coal', therefore, requires far more serious and persistent attention than the Government of India has so far paid to it.

Wanted not Ad hoc Committees, but permanent Ministries and Planning Commissions

Probably in this article, we have not been able to do full justice to all the points raised by the Mahindra Committee and deal with their specific recommendations. This is reserved for a separate article, but a close perusal of the recommendations shows that scarcely any of them is new. Many of them have been already suggested by previous committees, scientists like Sir L Fermor and Sir Cyril Fox, M S Krishnan and by writers in various articles in SCIENCE AND CULTURE and a very full symposium was held by the National Institute of Sciences in 1942, in which competent scientists, technicians, miners, and industrialists took part. Almost all the points discussed by the Mahindra Committee were more thoroughly and competently discussed. But both the Government of India and the members of the Committee appear to have been blissfully ignorant of the existence of the proceedings of the symposium, with the result that probably several lakhs of the taxpayer's money have been wasted in finding out facts which are already well-known.

'Ad hoc Committees' have been appointed as problems have arisen, but very few of the recommendations of these committees have been given effect to, and that too in a rather purfunctory way. It illustrates the well known attitude of the late bureaucratic government that the real motive behind appointment of ad hoc committees was to divert public attention when a problem became too inconvenient and to relapse back to complacence whenever the agitation died down.

Truth is the proverbial first casualty in war, but in India it is preserved in a comatic state in peace time as well. The result is that, when one endeavours to bring out the truth, he faces piles of files, reports, handbooks, memoranda, bulletins, etc., in which the facts are so neatly mingled with fiction that in order to sieve out the former one has to be prepared to bring out fresh reports. It is thus that the endless chain goes on with periods of complacency and forgetfulness and appointment of another 'Ad hoc Committee'.

Will not, therefore, the problem be better tackled if the Government creates a Ministry devoted solely to Fuel and Power, with permanent advisory bodies devoting itself completely and continuously to all coal-problems? These bodies may later form parts of the Fuel and Power section of the State Planning Commission.

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of a commission appointed a few years ago. The British firm which had installed the machinery had also provided log books, and instruments to find out whether combustion of coal was complete or not, from measurement of the amount of carbon monoxide which flew up the chimney. We found that these log books and instruments were never used or set up, and there appeared to be no check on the amount of coal used. Our impression was that if these automatic recorders were used, and coal was properly burnt, the cost might have been reduced by 50 per cent. In reply to our enquiry as to why the log books were not kept, and the automatic recorders were not used, the officer-in-charge said in a nonchalant way, 'Why should you insist on that, the water-supply has not failed, the station is working all right.' It appeared that nobody was interested in the saving of coal, which, if our guesses were right, would have saved several lakhs to the Corporation every year.

THE PLACE OF COSMIC RAY RESEARCH IN THE PHYSICAL SCIENCES*

P M S BLACKETT,
UNIVERSITY OF MANCHESTER

COSMIC Ray Research not only plays a major part in the physics of the fundamental atomic particles but has also important connections with the subjects of cosmology, geomagnetism and meteorology. The results of a very large number of experimental investigations have shown that the earth is continually being bombarded by very energetic atomic particles The origin of these rays is still almost completely unknown, and it is very probable that great advances in our knowledge of cosmology, that is, of the structure and history of the universe as a whole, will be required before a tenable theory of their origin can be found When the electrically charged cosmic rays approach the earth they are deflected by the earth's magnetic field in such a way as to make their intensity vary over the surface of the earth. The experimental and theoretical investigation of these effects, and of the variations in cosmic ray intensity during magnetic storms, has become an important branch of the subject of geomagnetism. When the rays enter the atmosphere they undergo complicated transformations by colliding with the molecules of air. The investigation of these atomic collisions forms a major part of modern cosmic ray research and has not only already led to very important discoveries, but takes one right to the heart of the unsolved problems of the fundamental laws of physics On the other hand, and contrary to what is sometimes reported, cosmic rays have today no direct practical importance Though the individual atomic particles which are continually bombarding the earth are of extremely high energy, the particles are so few in number that the total flow of energy into the earth is very small, in fact, no more than the energy of starlight, and this amounts to only about 2,000 horse power for the whole of the earth In contrast, the energy flow to the earth in the form of sunlight amounts to some 10^{14} horsepower, or about 1 kilowatt per square metre Here is a source of energy, nuclear energy, ready to be tapped directly for man's benefit Of course, our present main sources of power, coal and oil, wind and water power, are derived indirectly from solar energy

Prof P M S Blackett

The study of cosmic radiation has proved an especially happy hunting ground for the experimental physicist Already three new fundamental particles have been discovered amongst the rays and there is good reason to suppose that more will be found Before 1932, it was generally believed that the material universe was built up out of two fundamental particles, the heavy positively charged proton, and the light negatively charged electron Then in 1932, Chadwick discovered the neutron, with nearly the same mass as the proton but with no electric charge, and so with the property of passing readily through considerable thicknesses of matter. These three particles—the proton, the neutron and the electron, remain the bricks out of which we assume that the matter surrounding us is built. Though the three new particles revealed by cosmic ray studies in the years between 1932 and 1939, the positive electron, or positron, and the positive and negative meson, are all unstable under normal conditions on the earth, and so play no direct part in the constitution of ordinary matter, they do play an extremely important part in theoretical considerations concerning ordinary matter.

*Being the text of First B B Ray Memorial Lecture delivered in Calcutta on January 13-14, 1947.

The positron was discovered by C. D. Anderson in 1932 when he found on a cloud photograph a track of a particle with all the characteristics of an electron track except that its curvature indicated a positive charge. Early in 1933, Blackett and Occhialini confirmed this result by discovering showers of asso-

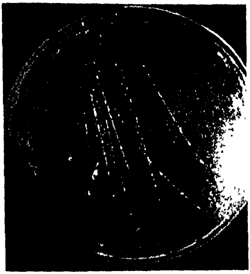

FIG 1 One of the first photographs of Cosmic Ray Showers About half of the sixteen tracks are curved to the left by the magnetic field of 3000 gauss and are negative electrons and one half to right are positive electrons
(*Blackett & Occhialini* 1933)

ciated cosmic ray particles containing about equal numbers of positive and negative electrons. They further identified the positron with the particle predicted by Dirac's famous hole theory, and explained its non-occurrence as part of ordinary matter, by attributing to it the properties characteristic of Dirac's particle, those of being born in an atomic collision as one of a pair of positive and negative electrons, and then after a very short life annihilating itself by collision with another negative electron

The nature of the main component of cosmic ray particles at sea level, which is characterized by great penetrating power, was for long in doubt. The main possibilities considered were that they consisted of (*a*) positive and negative protons, or (*b*) of positive and negative electrons but obeying quite different absorption laws to what theory led one to expect, or finally (*c*) a new type of particle Support for the last of the three hypotheses was given by Yukawa who, on theoretical grounds, predicted the existence of a particle of mass about 200 times that of an electron. Finally, the experimental demonstration that the penetrating cosmic rays at sea level were in fact of this character was made by Anderson, Street and others. Yukawa also predicted that such particles, if they existed, should be unstable and decay spontaneously with a mean life of about a millionth of a second into an electron of the same charge This instability of the meson was seen by Kuhlenkampf, Euler and Heisenberg to provide an explanation of some outstanding anomalies in the absorption of cosmic rays It is interesting thus to note that the existence of all these three new particles, the positive electron and the positive and negative meson, whose existence was proved experimentally by cosmic ray researches, was definitely foreshadowed by the theoretical analysis of quite different phenomena by Dirac and Yukawa. Dirac's anticipation of the positive electron arose out of his famous relativistic formulation of the quantum theory of the electron , Yukawa's anticipation of the meson arose out of an attempt to explain the short range binding forces between the constituent particles of atomic nuclei, and his predication of its instability arose out of the attempt to explain β-decay in radio-activity. This group of scientific discoveries is a good example not only of the fertility resulting from the close relationship between theory and experiment, but of the likelihood of theoretical investigation in one field bringing sudden illumination in a quite different field.

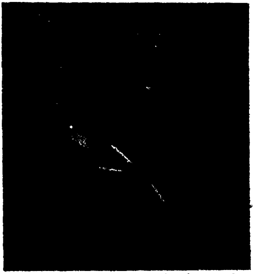

FIG. 2. An early photograph of a nuclear disintegration produced by cosmic rays in which three heavily ionizing rays, probably protons, and one electron are produced
(*Blackett & Occhialini*. 1934)

It is probable that still further fundamental particles will be discovered by future researches in cosmic rays In particular, there are strong general grounds for thinking that the negative proton should be produced in some very energetic collisions, but so far, however, it has eluded our search. Then there

may possibly exist mesons of more than one mass, or the uncharged meson, already named neutretto by theorists, though not yet discovered by the experimenter, or some hitherto unthought of particle.

Apart from the discovery of the new particles, the reason why the study of cosmic rays plays such a dominating role in modern physics lies in the enormously high energies of the individual particles. Whereas the energies of the rays emitted by radioactive substances range from 1 to 10 million electron volts (1 to 10×10^6 e v) the average cosmic ray at sea level has an energy of one thousand million electron volts (10^9 e v) and we believe that some of the rays incident on the top of the atmosphere may have energies exceeding 10^{11} e v. The collision of particles of such great energy is of great theoretical interest as it is just in such processes that we may expect to find the creation of new types of particles and the occurrence of new processes. It is only, in fact, by studying the intimate collisions of protons, neutrons, mesons and electrons that we can discover the forces acting between them. In particular, the magnetic moment and spin of the meson is not known; rather difficult experiments with mesons of energy of 10^9 to 10^{10} e v seem required before we can determine these important quantities.

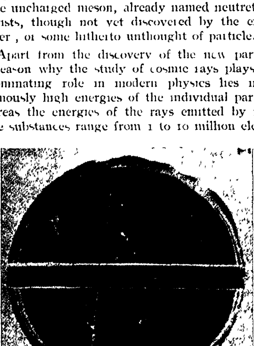

FIG 3. A shower of four penetrating particles, probably mesons. The three tracks passing through the 2 cm lead plate are of high energy. The one on the right is of a much lower energy.

(*Rochester* 1946)

The spontaneous decay of the mesons implies of course that they cannot be the primary particles falling on the earth, since they would have decayed into electrons before arrival. It is generally considered that the incident particles are mainly protons, a view point put forward by Johnson on the basis of his measurements of the latitude and East-West effects. The mesons are thought to be produced in the upper atmosphere by collision of protons with neutrons and protons (nucleons) in the nuclei of atoms of oxygen and nitrogen. The exact process by which this happens is not certain but it is clear that a proper theoretical description of such collisions involves some of the most intricate parts of modern theory, in particular the correct treatment of radiation damping. This again is bound up intimately with the problems of the basic laws of the fundamental particles. It is for these reasons that the investigation of the formation of mesons is of such great importance.

In traversing the atmosphere some of the mesons decay into electrons. This process provides a very elegant method of verifying one of the most profound deductions of Einstein's restricted principle of relativity. As was pointed out by Bhabha, the relativity theory shows that the mean life T of a meson moving with velocity V is given by terms of its mean life T_0 when at rest by the expression

$$T=\gamma\, T_0, \text{ where, } \gamma=\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}} \quad . \quad . \quad . \quad (1)$$

Now when the velocity v of the meson is very nearly equal to the velocity c of light, γ is a large quantity and so T is much larger than T_0. Thus a meson moving very fast lives much longer than if at rest. This is merely a particular example of Einstein's principle of the dilatation of time in a moving system. This variation of T with γ has been experimentally demonstrated recently by Rossi by observing the number of mesons of different energies which decay in traversing a given distance.

It is interesting to note that Einstein formulated his restricted principle of relativity on the basis of the failure to detect an influence of the earth's motion in its orbit on the measured velocity of light. Now the earth's velocity in its orbit is only about 10^{-4} of the velocity of light at such velocities the kinetic energy of a body is only about 10^{-8} of its rest energy mc^2. On experiments dealing with such low kinetic energies, the whole structure of relativity was built. Now by experiment with mesons its truth has been verified directly up to kinetic energies over 10 times their rest energy, that is 10^9 times larger than in the case of the original experiments on which relativity theory was based. Of course we believe the relativity theory to be true up to any energy of particle, because of the great generality of the theoretical analysis on which it is based however, it is useful to note up to what energies it actually has been verified.

For particles of the greatest energy that we are fairly sure about, that is about 10^{15} e.v., the predictions of relativity theory are striking. A

meson of such energy would have a life of about 10 seconds instead of a millionth of a second when at rest. And to an imaginary observer moving with the velocity of an electron of 10^{15} e v, the earth, instead of appearing spherical, would appear to be a flat disc of normal diameter but only one centimetre thick!

Due mainly to the fact that the meson is unstable, the subject of cosmic rays has now a close connection with meteorology. It had long been noticed that the intensity of cosmic rays appeared to decrease as the temperature of the atmosphere increased. At the time this seemed very difficult to understand. However, as soon as the instability of the meson became established a very simple explanation was given by Blackett. The mesons are formed high up in the atmosphere, and some of them decay before reaching sea level. If the temperature of the atmosphere increases, the atmosphere expands and the mesons are formed still higher up. They thus have further to go to reach the earth and so more of these decay, leading to a reduction of cosmic ray intensity with increase of atmospheric temperature. This link-up of cosmic ray measurements with the conditions in the upper atmosphere has opened up a wide field of research.

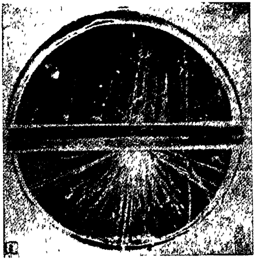

FIG 4. An unusual type of shower whose nature is not yet fully understood. A small number of penetrating particles have associated with them a larger number of lower energy rays which are probably positive and negative electrons.

(*Rochester* 1946)

The fact that cosmic ray research has become partly at any rate a geophysical subject, has given it a special character. For experiments have to be carried out not only in the normal physical laboratories but all over the globe and at great heights and great depths.

The first demonstration of the probable extra terrestrial origin of the rays was in fact made many years ago by Hess by experiments in a balloon. Since then numerous experiments have been carried out, not only with balloons, both manned and free, but in aircraft and rockets, in mines and deep under the sea.

There are four main instruments or methods which are used for the investigation of cosmic radiation,—the ionization chamber, the coincidence counting set, the cloud chamber and the photographic plate. The combination of the second and third, in the form of the counter controlled cloud chamber introduced by Blackett and Occhialini in 1932, has proved particularly useful because it has permitted the study of extremely rare atomic events. The photographic plate first used for the purpose by Blau and Wambacher, in its latest form as developed by Powell and Occhialini, is now equalling the cloud chamber in the beauty and detail of the tracks and surpassing it in the detection of certain types of rare events. Its limitation at present lies in the fact that only heavily ionizing particles are registered, that is, protons, alpha particles, larger nuclear fragments, and slow mesons. No photographic emulsion has yet been found which records the tracks of single fast electrons.

One of the most challenging problems at the present time is that of the nature of the primary particles which arrive at the earth, and the mechanism by which these primaries produce mesons near the top of the atmosphere. By an analysis of the East-West effect and the latitude effect, Johnson showed that the incident rays were mainly positively charged and so probably protons (P). It is thus probable that the positive and negative mesons (Y^+ and Y^-) which comprise the main penetrating component at sea level were formed by collisions of protons with the proton and neutron (P^+ and N^0) in the nuclei of the air molecules, by such a process as

$$\left.\begin{aligned} P^+ + N^0 &\longrightarrow P^+ + P^+ + Y^- \\ P^+ + P^+ &\longrightarrow P^+ + N^0 + Y^+ \end{aligned}\right\} \qquad (2)$$

The correct theoretical treatment of such energetic collisions is one of the most controversial facts of modern theoretical physics, but it is certain, both experimentally and theoretically, that the cross section for this process to occur is high, of the order at least of the nuclear area (Hamilton, Heitler and Peng). Janossy has pointed out that these theoretical cross sections are so large that an incident nucleon should collide with several nucleons while traversing a single nucleus and so produce a group of mesons.

However, it has recently been held by Bethe that the very high cross section of the Hamilton, Heitler and Peng theory for the production of single

mesons should be interpreted as a smaller cross section for the production of a number of mesons, according to transformations of the type

$$P^+ + N^0 \rightarrow P^+ + P^+ + Y^- + Y^+ + Y^- + Y^+ + Y^- \text{ etc} \quad (3)$$

Whether such single act multiplicities of this type do occur or not, is one of the most outstanding problems of cosmic ray research Heisenberg was the first to consider theoretically this type of multiple production of particles He considered that their processes occurred in close collisions of nucleons due to the occurrence of non-linear terms in the interaction forces

Experiments by Janossy and by Wataghin, with elaborate arrangements of counters have demonstrated the existence of associated penetrating particles—penetrating showers—but much further work is required before their nature will be fully understood It is quite possible that some of the particles in such showers are of a novel type.

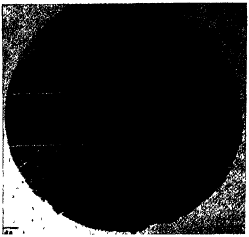

FIG 5 An explosion type of shower occurring in a 3 cm lead plate. The nature of the incident particles is not known for certain The two lightly ionizing particles emerging below the plate are probably electrons, the two heavily ionizing tracks on the left are probably protons, the curved track on the right is almost certainly a meson, probably born in the collision Its mass is found to be about 200 times the mass of an electron

(*Rochester, Butler, Runcorn* 1947)

When fast mesons traverse matter they occasionally make close collisions with atomic electrons setting them in rapid motion, or they radiate energetic photons while passing through the coulomb field of an atom In both cases, a cascade shower is produced, that is, a shower of positive and negative electrons and photons, produced by the two processes of pair production by photons, and the emission of photons by electrons. These cascade showers produced indirectly by mesons have been much studied both experimentally and theoretically Their particular importance lies in the fact that their frequency of occurrence is the only method known to us at present to deduce the spin and magnetic moment of a meson Actually it is not certain that the theory of such collision processes by mesons is established on a sure enough foundation to deduce a value of the spin. There seems to be considerable disagreement between the calculation by various theoreticians.

Auger and his collaborators have proved the existence of showers with a lateral spread at sea level up to 300 metres These are interpreted as consisting mainly of cascade showers of electrons and photons produced by primary electrons of energy up to 10^{15} e v. or more incident on the atmosphere It has been shown that all these extensive showers contain a few penetrating particles, but of what type and how they are found is still unclear One of the main difficulties of the experiments necessary to elucidate the details of these processes lies in the rarity of the events It is necessary often to observe phenomena which occur perhaps only once a day ; and this makes the collection of statistical evidence very tedious

It has long been known that nuclear disintegrations, generally called 'stars' from the appearance of the tracks, are produced by cosmic rays Some are certainly produced by neutrons which are presumably themselves produced by other nuclear disintegrations, but others are produced by charged particles These processes can be studied either by the cloud chamber method, or by the use of suitable photographic emulsions Though some of these disintegrations are probably of the type to be expected on Bohr's Drop Theory of the nucleus from the capture of neutrons, others are clearly much more complex In some of them one finds that protons, mesons and electrons are all emitted So far there is no theoretical explanation of the production of electrons in such processes Perhaps they may be the result of a kind of stimulated β-ray emission, possibly associated with the hypothetical short life meson introduced into nuclear theory by Möller and Rosenfeld.

Of the origin of the primary cosmic rays incident on the earth there is little that can be said for certain The fact that their intensity is nearly constant in time implies, since the earth is rotating, that they must come nearly uniformly from all directions in space It is possible that such variations may be association with either the rotation of the galaxy as suggested by Compton and Getting or possibly with the uneven distribution of the matter of the galaxy with respect to the earth as suggested by Duperier. The minuteness of the effects and the complication of the phenomena involved in the passage of the rays throughout both the sun's end and the earth's magnetic field

and then through the atmosphere, make their investigation very lengthy and the analysis very difficult. It will certainly take many years' patient work before we can be sure of relating the observed intensity of cosmic rays on the earth to definite cosmological phenomena.

BIOLOGICAL CONCEPTS

BHUPENDRANATH MUKHOPADHYAYA,

CALCUTTA

THE history of scientific advance is littered with discarded theories and hypotheses, but the leading concepts of science are less numerous and more stable Empiricism, which is the true opposite of science and which consists in using the results of observation and experience without attempting seriously to understand their true meaning, forms laws and theories to be discarded eventually on the shedding of a new ray of light from science. But the concepts of science are the sure foundation of a different attitude which is termed scientific

Scientific advancement proceeds from scientific concepts Aristotle's conception of fixed and quite distinct species was prevalent among the biologists of the Linnean period , and the descriptive phase of Botany was thus characterized by a desire to know, classify and record as many species of plant as possible, and add to that by new collections from all the ends of the earth. As long as the concept of fixed species remained predominant in the minds of the scientists, such collection and description yielded useul results, and satisfied the urge to know the unknown But with the advent of the Darwinian period, it became increasingly difficult for such a static notion to hold the absorbing attention of the scientific mind. Instead of taking the existing species of plants and animals for granted, it was necessary to probe into their origin and development The problem of descent, which included the construction of phylogenetic system, became the chief aim of the phyletic period of Botany. The new concept gave a dynamic outlook, and the old habit of viewing things with a static gaze was abandoned for good.

Only correct concept can raise science from the level of magic, by its elaboration into scientific theories and principles, and distinguishing scientific operations from magical rites. Primitive agriculture of the people of ruder culture for instance, has its strictly scientific aspects ; but the whole operation is so much mixed up with pseudo-religious faiths and superstitious beliefs, due to the lack of a reliable concept, that their agricultural activity appears more magical than scientific Indeed, no one would regard an appeal to the supernatural as strictly scientific * For, the object of science is to give rational account of things, not to invoke inscrutable, *ad hoc* powers to explain them away

Mere examination of facts and search for utility leads nowhere. It is the desire for an explanation that gives science the impetus to take its first step towards concept-building Chemistry acquired its concepts about two hundred years ago and since then has gone ahead. Before that, it had been a tool in the hands of the alchemists to play frauds with The notion of chemical substance as something possessing a number of specific properties came fairly late in the history of chemistry Thus, if one specific property is found to be changed, the rest are changed also ; and this can only be possible through a chemical process, involving conversion of one substance into another substance or substances. Again, things may be physically homogeneous and yet chemically heterogeneous Given these notions, but not till then, real chemistry can begin. The notion of chemical substance is not self-evident, nor can it be gathered from general physical consideration any more than the notion of what constitutes a species of plant can be arrived at from the popular idea of 'pot-herbs'. In fact the evidence of general observation is against specific properties and in favour of transmutation There was no reason, therefore, why one should not expect to turn lead into gold ; it was only a matter of changing one property, *viz.*, the colour, just as one can change water into vapour or ice, or a man into a fascist or communist. Lacking the necessary notion, "Newton

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* Appeals to the supernatural for help to gain specific end are not uncommon even in the scientifically organized countries of Europe. Praying for victory over the enemy was a common feature in their Church services during the years of the war. As regards the efficacy of prayer, Prof J. B. S. Haldane writes, "In the absence of experimental evidence Galton attempted a statistical investigation . . . The conclusion to which his numbers led was that the much-prayed-for persons had slightly shorter lives than those with whom he compared them The difference was not, however, great enough to make it probable that prayers have any harmful effect."

could acquiesce in statements such as that water even when redistilled several times leaves a residue on evaporation, or that mercury at ordinary temperatures may be solid or liquid" But given the notion, such statements become impossible.

Concepts are the solid grounds which bear the weight of the super-structure of high-flown theories, as the poverty of the Indian masses bear the weight of the concentration of wealth at the hands of a degenerate aristocracy Without correct concepts theories atrophy and techniques stagnate The construction of electronic microscope has become possible, because it is realized that it is impossible to 'see' an object smaller than the light-wave, unless some other medium of shorter wave-length replaces light A flow of electrons answers the requirements of such a medium, and the magnetic field replaces the glass-lens.

While theories and techniques belong to the fast moving currents of advancing science, the leading concepts are its solid rocks New theories gather momentum from experiments and observations, and wash away old ones from the shores of knowledge, but the fundamental concepts stand out—immovable and unperturbed

Take, for instance, the concept of organic evolution , Darwin did not invent it any more than Hitler invented racial hatred , the speculative Greeks had already suggested such a possibility hundreds of years before Darwinism came into being. In fact, the Hindu doctrine of 'Karma' and 'Rebirth' savours of an evolutionary idea What Lamarck and Darwin tried to do was to explain evolutionary tendencies in the organic world as best as they could, and formulate theories to embody their explanations We no longer agree with Lamarck that characters acquired by the conscious effort of the individual are inherited, or with Darwin that Natural Selection by itself is sufficient to explain evolution Modern genetical biology no longer accepts Weismann's Germ-cell theory in the form in which the author stated it, nor does it subscribe to the time-honoured distinction between inherited and acquired characteristics. But about the fundamental notion of evolution, that is to say, that the organisms now living are descended from ancestors from whom they differ very considerably, there is a singularly universal agreement among Biologists The theories of evolution change, but the evolutionary concept which throws these theories up from time to time remains

Yet, the leading concepts of science are not immutable permanent acquisitions. They too change, but change less frequently and more fundamentally, and often with devastating results The notion of geo-centric universe was explained by Copernicus, evoking great hostility from the Church ; Darwin struck at the root of the idea of "Special Creation" and created a great commotion ; abiogenesis gave way to biogenesis ; Pavlov's conditioned reflexes have thrown a new light upon the relation of mind and body, and compelled us to reconsider the question of free-will , Einstien's relativity has altered our conception of the nature of time and space, while Planck's quanta have revolutionized our idea of energy and matter , and we are now asked to revise our opinion about ether in the light of Michelson-Morley experiment.

Thus, the leading concepts of science are not essentially different from the ordinary scientific theories except that while the latter, to use the terminology of J S Mill, are good, valid, useful Second Principles, the former belong to the category of First Principles Second Principles are constantly being tested by experience, experiments and observations, and are altered or abandoned in the light of new knowledge to give logical coherence to our understanding of specific problems. First Principles, on the other hand, are the basic principles of sciences for the opening up of possibilities as much as for the laying down of laws. They are general in outlook, wide in application, and are actually the prior assumptions which are necessary to understand any facts at all There is no restriction as to making these assumptions except that they must be scientific in spirit, *i e* , as far as possible, they must be minimum assumptions in consonance with the observations and having universal application It is sometimes possible to choose from alternative assumptions ; but if we accept A out of three possible assumptions—A, B, and C, we must reject B and C ; and further, we must also accept all the possible consequences of asserting A The consequences often appear as new problems which may remain unsolved, until the primary assumption (concept) which gave rise to them is superseded by a new one, when they too disappear.

To illustrate this, take the spatial movement of heavenly bodies the early astronomers assumed that the stars and planets were carried round the earth on spheres, the spheres having each a simple circular movement The observed motions could be described to a high degree of accuracy on this assumption ; but it created new problems that remained unsolved, *e g* , how were the motions of the spheres maintained and communicated to one another? And what was the composition of those spheres? The next stage in the development of Astronomy saw the abandonment of the spheres The sun and the stars were brought to a state of rest and the earth and planets made to revolve round the sun in elliptical orbits under the influence of gravitation. The new assumption, therefore, replaced the moving spheres by the gravitational force. With tho introduction of the

new concept the old unsolved problems, *viz.*, the composition of spheres, etc., simply disappeared, but fresh problems cropped up, *e.g.*, what would be the physical properties of a medium which could bear such an enormous strain of holding the planets in their orbits and yet would offer no resistance to their motion? And what would be the velocity of the solar system through this medium? These questions received no answer until yet another new concept about the universe rendered their solution unnecessary. Gravitational force has now been discarded; and we no longer imagine a planet to be tied to a distant sun. It moves freely along its path, taking the easiest course in a 'space-time' having a 'curvature' which distinguishes one direction of motion from another. This new concept has given birth to yet another set of consequential problems, which, however, need not detain us here, as they properly belong to the domain of physics.

The concepts of physics are now well-developed and clear enough, but there exist still doubts about some of the leading concepts of biology. It is, therefore, no wonder that the development of biology from the time of Aristotle to the present day has been rather slow and uncertain. It is, for instance, not yet clear what constitutes a species of plant or animal. Describing and classifying have been the most prominent feature of biological development. As Prof. J. B. S. Haldane puts it,—"At present much of biology is in the stage of measuring and waiting for the idea."

The first working conception of the systematic biologists was to regard different species of plants and animals as fixed in character, and distinct from one another without intermediate and overlapping forms. This gave them a good start; but the notion, like the notion of a chemical substance, is an approximation. There is now overwhelming evidence both from living species (*e.g.*, willows, blackberries, ducks, pheasants etc.) and fossil specimens which shows that the species of plants and animals do not always display complete specific distinctness. The apparent fixity of character is due to the shortness of human time-scale in a world where an annual or a longer reproductive cycle is the rule, except among small inconspicuous creatures, such as bacteria, where the fixity of their specific characters is dependent upon the fixity of their environments.

The conception of evolution seems now to be established on firm grounds. As regards the affinity of the living species of plants and animals with their ancestral forms, it is interesting to note that man resembles the chimpanzee and other tailless apes, and differs from the tailed monkeys, in many anatomical characters well-known to the biologists of the present day. Thus, the chemical anatomy also lends support to the physical in establishing affinity. The study of genetics, besides fossils, supplies the most interesting information about evolution. Our knowledge of the genes as heredity-determining units together with our improved technique provoking mutations by mild injury on the germ plasm of animals, such as mice and flies, with X-rays or radium, makes it possible to study the important problems of inheritance and mutation at close quarters. The results of actual observations, contrary to the expectation inspired by the conception of evolution, however, do not show that the variations are mainly in any one direction or that majority of them are of advantage to their possessor. For instance, out of 400 mutations observed in one fly, all but two seemed to be disadvantageous to the fly, and these mutations showed no definite tendency in any one direction. These results are no doubt disturbing from the point of view of 'survival of the fittest', and they make it difficult to visualize the whole evolution as taking place from chance variations, and Natural Selection alone acting upon them. These are the difficulties associated with the question of variation.

The difficulties connected with the questions of transmission of characters acquired, and selection, are by no means small. The work of Weissmann raised insuperable difficulty in the way of acceptance of the former factor; and the majority of biologists today doubt whether acquired characters are transmitted to the offspring. Working on the possible effect on an organ of its use or disuse throughout seventy-five generations of *Drosophila*, Payne was unable to show any transmission of acquired character. Other experiments on the inheritance of the effects of use and disuse have also given negative results. It may, however, be argued, as has been done by Samuel Butler, that the effect sought for in these experiments had not had enough time to fix itself during the comparatively short time of the experimental period, but might show its importance in geological time. While paying due regard to this very pertinent argument, it must not be forgotten, however, that the worker-bees exhibit most perfect and complex instincts and yet most of them are descended from the queens and drones which do not share their virtues. It is surprising, therefore, that the workers should have refused to change their instincts for those of the sexual forms for as long a time as twenty million years. The present position regarding this important subject is that, all characters are, as Goodrich puts it, both inherited and acquired. There is, therefore, no fundamental distinction between the two. Actually, what is inherited is not a character at all, but certain material which, given certain conditions, will produce certain character.

The case for natural selection is, however, much stronger. It has been found that wheat taken from

Scandinavia to Central Europe and brought back again after a few years, germinate earlier than its ancestors. The reason for this is that, while in Scandinavia the early germinating shoots would be nipped by frost, in warmer climate of Central Europe they would get a start over the others, and would be in greater numbers in each successive generation Any inheritable variation determining early sprouting would be favoured by selection, and the wheat as a whole would tend to sprout earlier. It is, however, important to note that natural selection is a negative factor in the sense that it only accounts for the non-survival of those forms which have died out. Further, it can act only when there are variations to act on , there is nothing directional about it. Moreover, where the environment is fairly constant, as in the sea, natural selection will be the least important of evolutionary factors. It is no wonder, therefore, that many marine living forms closely resemble the earliest fossils from the Cambrian rocks But the real dangers to the acceptance of 'natural selection' are the parasitic and symbiotic associations between different organisms ; these life-forms seem to have managed to get round natural selection very successfully

The concept of evolution which draws its sustenance mainly from the idea of variation, inheritance and selection, has not received as much support from experimental evidence as could be desired. Nevertheless, the notion of evolution can be said to have struck as firm a root upon biology as the notion of relativity upon modern physics and socialism upon modern society.

Less firmly established, and, perhaps, more widely talked about than evolution, is the notion of 'progress'. Having gained its main support from the material advancement of the human society, the notion is desperately trying to instal itself in the biological science in order to re-establish the primacy of man among living creatures, which was so rudely, but successfully challenged by Darwin If we are not the special creation of God, we must at least be His best creation The idea of progress arose as a result of bias on the part of popular evolutionary notion, that lays stress on the ancestry of such animals as men, horses, and birds, which are, judged from the human standard of value, superior to their ancestral forms. There is, therefore, a tacit understanding of progress in the popular mind when it contemplates evolution, as there is an assurance of respectability in the contemplation of bank-balance.

But progress does not seem to be the rule in evolution. According to Prof. J. B. S. Haldane, "For every case of progress there are ten of degeneration". And he cites, as examples, the loss of flight in Ostrich and its allies, the Kiwi, the Dodo, etc. Parasitism, which hundreds of groups have independently taken to, in order to achieve a high degree of adaptation to environment, is a capital, example of most profound degeneration associated with evolution. Finally, since it is implied in the assertion of life's freedom that life is as free to fail as it is to succeed, there is no reason to suppose that evolution means continuous progress.

The notion that lies hidden in the idea of progress and flows naturally from it, is that of 'purpose' Purpose implies goal , and development, a growing capacity to realize that goal. Further, purposive life implies that life at any given stage of development is conscious that it has reached that stage and that a further stage is ahead Mr George Bernard Shaw's frequent assertions that the process of life's evolution is neither infallible nor inevitable but proceeds by the method of trial and error, suggest this purposiveness of life Of course, there is a great danger in using the notion in biology, if purpose means conscious deliberate purpose Unconscious, blind purpose is simply meaningless and is a contradiction in terms. The concept of 'purpose' really belongs to the domain of philosophy ; its introduction in biological science is, therefore, likely to create a certain amount of confusion, if not contradiction And so it has As Prof Ritchie so aptly put, "It is absurd to discuss the structure of the eye without mentioning that the eye is *for* something But if to *look at* something means deliberation and conscious purpose, we can be pretty sure no insect ever *looks at* anything Are we then to say it never *sees*? "Or, shall we say?—

"Into this Universe, and why not knowing,
Nor whence, like Water willy-nilly flowing
And out of it, as wind along the Waste,
I know not whither, our willy-nilly blowing."

It is clear that the leading concepts of biology, though they are useful as working hypotheses, have not yet gathered sufficient strength and stability to be able to face squarely the challenge put up from time to time by the evidence of the experimenters in the biological arena There are, however, a few modern concepts which seem at the moment to have wider application, and, therefore, a little more binding force. But they are formulated in such wide and loose terms that it is doubtful if they deserve the name, 'concept'.

A concept opposed to the mechanistic conception of life, is based on the fact that living organisms exhibit what can only be called an inner drive to reach their appropriate form, and, when it is reached, to maintain it ; and that they also exhibit a similar drive to reach and maintain an environment appropriate to their proper functioning. This has been termed, "The conception of the organism as a self-maintaining, though changing, pattern of ordered

relations." Vegetative reproductions from cuttings of stems and from leaves of plants afford as obvious an illustration of the concept as the behaviour of a crab in growing a new leg when one is knocked off. The most interesting example of this concept is, however, supplied by the experiments of Drisch, in which an embryo was cut into several sections before reaching the stage of differentiation of its cells, and each section was afterwards found to develop into a complete embryo Since these cuts could be made along an almost infinite number of planes, any one portion of the embryo must be presumed to be able to develop any characteristics and assume any function Further, any one part must also be credited with the knowledge of how the other parts are developing.

Adaptations to changed environments by alterations of structures are too numerous to need any example here Prof Haldane's work on the delicately adjusted responses to the variations in oxygen supply also gave very good results. The biological concept we are now discussing can be expressed slightly differently by quoting from Prof. Haldane, who said, "The conception of life embraces the environment of an organism, as well as what *within* its body " "The proper unit for biological investigation," in Prof Haldane's opinion, "is not the living organism at all, but the organism plus its environment "

As one of the biological concepts Prof Ritchie suggests, "the notion that every organism has a 'specification' in the engineer's sense and yet that this is not rigid but always allows for variation " The 'specification' which is not rigid and allows for variations, can hardly be called specification at all, much less in the engineer's sense. However, every species has its specific structural form of which the reproductive part is less susceptible to variation in response to environment than the vegetative part

In modern biological thoughts life's creative activity is often expressed in the 'doctrine of emergence' originally propounded by Prof Lloyd Morgan Although its importance in experimental biology is not yet very great, owing to the fact that we have no direct control over the emergent characters, the doctrine is nevertheless very useful in understanding creative evolution The occurrence of variations in species, which presents an insurmountable difficulty to the purely materialist view of evolution, is merely a particular example of a process which, the doctrine assumes, goes on continually in nature. Whether the variation in question is a non-inheritable fluctuation due to the evironment, or mutation giving rise to a new gene, or a mere reshuffling of genes making the variation inheritable, the appearance of novelty in each case is explained by the doctrine of emergence. The doctrine asserts that the development of life 'consists in the continual throwing up of new qualities which were not present in any of the antecedents from which the entity possessing the qualities sprang." In the world of materialist physics there can never be more in the result than there was in the cause , and all apparent change or growth must be a rearrangement of existing material. But with living organisms, if the doctrine is correct, this is not so. It is important to realize that acceptance of this doctrine as a concept of biology would involve us in the conclusion that the behaviour of life is essentially different from that of matter ; and that at any given moment in the development of an organism, the organism is more than it was at the preceding moment.

Another concept of life's progress, analogous to the above concept, is what General Smuts calls Holism Biological progress proceeds, according to this concept, by the integration of more and more elements to form larger and larger organic wholes Holism is thus defined as the fundamental factor operative towards the creation of wholes in the Universe, the whole being more than the sum of its parts The reason why this important subject will not be pursued here any further, is not because this South African genius himself follows a contrary path of dividing the whole and creating friction among its parts, so that the parts behave as if they are less than themselves ; nor because his anti-social actions, on the view that human agency is but a form of natural agency, are a glaring exception to his holy conception of Holism ; but because this new conception has stimulated more philosophic speculation than scientific thought, and as such is not very relevant to biological sciences In passing over this subject it may be mentioned, however, that the conception of the whole being greater the sum of its parts is not new to the Indian mind which knows —

> "Shahasra sheershah purushah shahasraksha
> shahasra pad
> Swabhuming sarbatobyapya atyatisthat
> dashangulam "

It is clear that most of the concepts of biology lack in precision , and in a few cases where they do not, the experimental results not infrequently tend to restrict their application by obstinately refusing to conform to their tenor. Only the conception of evolution seems to have attained the kind of universality demanded of a scientific concept. In the words of Dr Needham, "The persistent existence of the lowest forms of life (to which Prof. Ritchie directed attention); or the fact that parasites may achieve a high degree of adaptation to environment at the cost of profound degeneration, or the continuation of evolution (in Prof. R A. Fisher's phrase) 'in the teeth of a storm of adverse mutations' have nothing to do with the inescapable fact that, during biological evolution,

the degree of complexity and organisation has increased."

The difficulties of concept-formation in biology are many The greatest of them all is probably the fact that the lower end of the scale of life behaves quite differently from the higher end According to Dr Julian Huxley and his grandfather T H Huxley, man's moral progress is not only not in line with animal evolution but in some ways a reversal of it Further, no definite line of demarcation is to be found between the two ends of the life-scale In fact, there does not seem to be any definite gap even between the living and the lifeless The convenient gap that once seemed to exist between the simplest bacteria and the most complex protein structure now appears to be bridged by the viruses. It may appear hopeful that since the time-honoured distinction between the living and the life-less is gradually breaking down, it may be increasingly possible to apply concepts of physical sciences to biology But all such hopes fade away when it is realized, that although biology has been applying—as it must apply, because of the fundamental unity of all sciences—physical concepts on appropriate occasions, the categories of physics are utterly inadequate to deal with living forms, much less higher manifestations of life Some of the modern physicists are, in fact, beginning to doubt whether these traditional categories are adequate even within the physical realm Mr George Bernard Shaw was, therefore, pertinent in questioning the physicists' data regarding the distance of the sun from the earth, as there is no guarantee that our conception of space is an adequate guide in the measurement of inter-stellar 'distances'

In the face of these and other fundamental difficulties (*e.g.*, brevity of human time-scale, apparent consciousness of living matter, etc.) that lie in the path of the biologist, it is not at all surprising that the progress of the science of life has not been as spectacular as that of the sciences which deal with dead matters. It may be that the accepted scientific technique—that of looking at one set of things at a time and leaving out the rest—, though it is intrinsic to the physical science, is really extrinsic to the science of biology, and cannot, therefore, be expected to have access to the secrets of life. What we probably need is new technique intrinsic to biology, and fresh attitude consistent with pulsating life Perhaps, John Dewey gives the answer in his assertion that, "Nothing short of the whole experience is a *datum, given* in compulsive fashion Any item within experience is *taken*, selected by us, and often selected for a purpose. Our power of selection is limited by the fact that purpose can be fulfilled only if selection is made consistently and according to rule Some of these rules are matters of ordinary everyday habit and there is no apparent difficulty about them. The difficulties appear when we go behind them to the grounds they rest on , from ordinary Second Principles to First Principles " Or, perhaps, Boutroux was right when he said, "According to the results of science herself, there is nothing to guarantee the absolute stability of even the most general laws that man has been able to discover Nature evolves, perhaps even fundamentally "

Fortunately, the heavy clouds of pessimism betray a ray of assuring optimism ; and it conduces much to our content that man is in evolving Nature

PROFESSOR P N GHOSH MEMORIAL FUND

We understand that a Memorial Fund has been created to perpetuate, in a befitting manner, the memory of late Professor Phanindra Nath Ghosh whose death has removed a distinguished scientist and educationist from India The Professor P N Ghosh Memorial Fund Committee has been formed with Prof M. N Saha and Prof S K Mitra as President and Vice-President, Dr P C. Mahanti as Treasurer, and Dr A. K Sen Gupta and Mr Hiren Basu as joint secretaries The following are the members of the Committee Dr H K. Rakshit, Mr M R. Datta, Mr C S Ghosh, Mr S N Chakravarty, Dr Saroj Dutt, Mr D. N. Ghosh, Mr N L Dutt, Mr M. K. Mukherjee, Mr Alak Ghosh, Mr B. B. Sarkar, and Mr H. P. Bhattacharya The Memorial Committee has recently issued an appeal for donation to which, we hope, the numerous friends, students and admirers of late Professor Ghosh will generously respond.

THE MULTI-PURPOSE DEVELOPMENT OF THE TENNESSEE RIVER*

W L VOORDUIN,

CENTRAL TECHNICAL POWER BOARD

INTRODUCTION

TO-DAY we shall discuss the multi-purpose development of the Tennessee River, and in order to do proper justice to the subject I should first attempt to give you a picture of the background of the Tennessee Valley Authority—in other words, the history which led up to its creation, with particular emphasis on the history of the development of navigation, flood control and hydro-electric power, which are the three major purposes in the T V A programme I know of no better way than to summarize in part a paper by James Lawrence Fly, formerly Chief Counsel of the T V A For those of you who would like to have a more complete picture, I should mention that this paper was published in the Pennsylvania Law Review of January 1938

T V A 's HISTORICAL BACKGROUND

Navigation . From the earliest days in the history of the United States, the Federal Government, under the pressure of public opinion, interested itself in the waterways of the nation

The beginning of the nineteenth century, which incidentally was only shortly after the founding of the Republic, found Fulton, the inventor of the steam boat, and Livingston, who as Ambassador to France had negotiated the Lousiana Purchase, in the possession of a monopoly over the navigation rights of two of the most important rivers in the United States, namely, the Mississippi and the Hudson rivers Some of the coastal States had already conferred exclusive navigation rights on contiguous waters to private interests and bitter conflicts due to commercial rivalry, led to recriminatory statutes by different State legislatures Arising out of these conflicts came the famous case of Ogden vs Gibbons, where one of the litigants had traversed the waters over which the other had an exclusive navigation franchise granted by Livingston and Fulton The opinion of Chief Justice Marshall of the Supreme Court in this case established for all time the exclusive control of the National Government over interstate navigation.

The back of the first great monopoly over the nation's water resources was broken , a spurt of activity followed, and President Monroe forwarded to the Congress an ambitious plan for improved roads and waterways which included the improvement of a portion of the Tennessee river. However, in those days, and I am speaking of some 120 years ago, the States rights theory was popular and the National Government was hesitant to assume direct responsibility for waterways development It took another quarter of a century before President Fillmore recommended that the Federal Government assume direct responsibility for waterways improvements for the reason "that if these works, of such evident importance and utility, are not to be accomplished by Congress they cannot be accomplished at all"

Meanwhile the Courts too were consistently laying the foundation for a broad Federal water resources policy by denying all attempts to limit the Government's power, upholding its rights to clear the rivers of obstructions to navigation and recognizing the relation of water power to physical structures for navigation which had concentrated the rivers fall in one place

Actual development of the rivers did not keep pace with the scope of Congressional power as defined by the Court decisions, and shortly after the turn of the 20th Century, President Theodore Roosevelt complained of the neglected condition of the rivers in spite of the fact that "in extent, distribution, navigability and ease of use (our rivers) stand first"

During the first World War existing transportation was unable to carry the burden of wartime traffic and conditions of economic and social unbalance looked to water transportation as a possible remedy. Predating the war, the completion of the Panama Canal had also contributed to unbalance previously existing conditions

For instance, Atlantic seaboard industries could profitably compete for west coast business with inland industries located much nearer to the market. Herbert Hoover, then Secretary of Commerce, stated in 1927 "we must find fundamentally cheaper transportation for our grain and bulk commodities which we export and the raw materials which we import into the Mid-West". As the situation became more and more acute, comprehensive plans for inland navigation were evolved.

Flood Control . In the early days flood control had been regarded largely as a local responsibility and earlier Congressional appropriations prohibited

* Being the text of Readership Lectures delivered by Mr W. L. Voorduin, C.E., at the Calcutta University in July, 1946.

the use of Federal funds for construction and repair of levees for flood control or for any other purpose except as a means of deepening river channels for navigation. Although some of the Presidents of the United States had broader views on the subject, as evidenced by their messages to the Congress, it was not until 1890 that appropriation measures permitted expenditure of funds not only to improve navigation, but also to promote the broader interests of commerce. However, local governmental units and districts continued to bear a large part of the financial burden and responsibility for flood protection.

Following the 1916 flood and again in 1923 Congress provided substantial appropriations for flood control purposes and these were the first real flood control acts.

After another flood disaster in 1927 it became generally recognised that a great flood was a national problem. Although approximately the same land areas were covered as in the 1912 flood, the damage was four times greater in the 1927 flood, due to greater development in the river valleys. The Flood Control Act of 1928, drafted to meet a critical emergency, provided immediately only for continuation of flood control by an extension of the levee system and diversion floodways, but at the same time directed the early completion of studies to supplement the levees by a system of tributary reservoirs.

It is now generally recognised that levees must not be depended upon as the only means of protection, they must be supplemented by reservoirs. Such a system emphasises more than ever before the interdependence of navigation and flood control. The same structure which holds back the water in times of flood also provides the flow to maintain a navigable channel in dry seasons. This was recognised by the Supreme Court in a decision in 1913. Thus, engineering conclusions were translated into legal principle.

Hydro-electric Power : Hydraulics is one of the oldest sciences known to men and the earliest development of water power is lost in antiquity. However, hydro-electric power, and particularly large scale development, made possible by the advances in the engineering science, is only of comparatively recent origin and may be placed for all practical purposes somewhere near the beginning of the 20th Century. In the United States hydro-electric power was developed at first mainly by private power companies and individuals, operating as monopolies under licence from the States and later under licence from the Federal Power Commission. The rates for electricity were controlled by State Utility Commissions.

This system of operation resulted in vast fortunes being gained by a few enterprising individuals and utility companies, and under the impetus of the promise of ever-greater profits it was also responsible for some of the great advances in the development of hydro-electric power, which were made in the beginning of the 20th Century. However, it cannot be said that this system was wholly satisfactory as evidenced by some of the spectacular failures of utility empires during the depression years following the first World War.

Many were also of the opinion that the Nation's share of natural resources was not adequately distributed amongst the people, and this gave rise to legislation such as the Federal Water Power Act of 1920.

Aside from collection of taxes and license fees, the Federal Government did not have a direct interest in single-purpose hydro-electric developments. In 1906, however, an amendment to the Reclamation Act provided for the disposition of surplus electric power made available at irrigation projects. The Constitutionality of the Act was vigorously attacked by private interests, but the Act was held valid as a means of improving the public domain to make it marketable.

Federally owned hydro-electric power stations had also been installed at Government navigation dams, notably at the Wilson Dam on the Tennessee River, on which work was started in April 1918 shortly before the cessation of hostilities in World War I and which was completed in 1925.

Almost immediately after the completion of the Wilson Dam, debates began by the public and in the Congress for final disposition of this project which had cost some fifteen crores of rupees to build during the war years. In these debates which lasted until 1933, Senator Norris of Nebraska was the main proponent of the public interest and the first T V A. Act was drafted under his guidance.

The T V A Act

The Tennessee Valley Authority Act was passed as one of the first acts of the Roosevelt Administration in 1933, and was introduced by the President in the following words:

> "I, therefore, suggest to the Congress legislation to create a Tennessee Valley Authority—a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise. It should be charged with the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin and its adjoining territory for the general social and economic welfare of the Nation."

The Act provides for navigation improvements, flood control, distribution and sale of surplus power, reforestation, proper use of marginal lands, agricultural and industrial development, production and sale of fertilisers, national defence and other purposes.

Power to execute the provisions of the Act was vested in a board of directors, composed of three

members, appointed by the President, by and with the advice and consent of the Senate. The Corporation was empowered to construct dams, reservoirs, powerhouses, transmission lines, navigation projects and other structures and to acquire land for these purposes, if necessary by condemnation

Funds for construction and other purposes were to be obtained by Congressional appropriations and the Corporation was required to file an annual report covering its activities during the preceding fiscal year All transactions of the Corporation were made subject to an audit by the Comptroller General of the United States

The original T V A. Act, which was amended several times, also empowered the newly created Authority to begin construction of the Norris Dam, named after the veteran Senator from Nebraska

Thus, the Authority was told to develop or aid in the development of all the natural resources of the region, the river, the land, the forests and the minerals. This was no real extension of Federal responsibility because the Federal Government had furnished, for a long time, technical and financial aid for the development of lands, rivers, minerals and forests separately The only new feature was the combination of all these responsibilities in one agency

Nevertheless, the T V A was not free from attack in the public Press and in the Courts, emanating from the same sources which had so frequently in the past attacked the development of natural resources for the public benefit These attacks have not done any harm, they have helped to consolidate public opinion, they have established beyond all reasonable doubt the constitutionality of the programme and they have kept the organization on its toes.

The constitutionality of the T.V A Act has been tested in several Court cases. In the so-called Ashwander case the Courts established that

(i) the Wilson Dam had been constitutionally constructed ;

(ii) the Federal Government had full authority to instal generating equipment ,

and (iii) energy generated could be disposed of, if necessary, by acquisition of facilities for its transmission to the market

Broad questions of constitutional validity were also involved in the case of the Tennessee Electric Power Company *vs* the Tennessee Valley Authority, in which 18 Power Companies operating in the Tennessee Valley and surrounding territory had combined as plaintiffs. Here again the Court upheld the validity of the statute in all its aspects.

The Supreme Court also held, in a related case, that the Federal Government could construct dual purpose projects for flood control and power development, and that the power so generated could be sold to defray the cost of flood control

The Congress, too, after approximately five years of operation of the T V A , appointed a Committee to investigate the affairs of the T.V A. in all its aspects, and the conclusions of the Committee were quite generally favourable to the Authority.

T V A PROGRAMME

General. In the execution of its tasks in the now approximately 13 years of its existence, the T.V A has built 7 dams on the main Tennessee River and 9 dams on the tributaries, as well as one large thermal electric station Five dams and four thermal electric stations were purchased from the Tennessee Electric Power Company, while the Wilson Dam and a thermal electric station near the dam were taken over by the T V A at the time of its creation In addition, five dams of the Aluminium Company of America are being operated as a part of the integrated system which controls the flow in the Tennessee River

The multi-purpose system provides a navigation channel 650 miles long from the mouth of the Tennessee River to Knoxville, Tennessee ; has more than 13 million acre feet of storage capacity useful for flood control, navigation and power purposes, and the generating capacity in the T V A owned hydro and steam plants exceeds two million two hundred thousand Kilowatts.

Navigation Operations In the three calendar years 1942, 1943 and 1944, navigation on the river amounted to about 139 million, 194 million and 160 million ton miles respectively The decrease in 1944 was due to closure of the navigation lock at Kentucky Dam, near the mouth of the Tennessee river, for a period of two months in order to complete construction work In the first half of 1945 the upward trend, which had been in evidence for 6 years, was resumed and the river traffic during a six month period amounted to nearly 125 million ton miles. These figures are exclusive of sand and gravel shipments which bulk large in tonnage but are usually carried over small distances Sand and gravel shipments amount to approximately 15 to 20 million ton miles annually

Freight carried included military vehicles, pig iron, limestone, machinery, lumber, coal, coke, grain and petroleum products Grain moving into the Tennessee Valley from Mid-West points is new on the river since the T.V.A. development. Many ocean going cargo vessels have been launched on the Tennessee River and ship-building is a thriving industry.

Several of the larger Companies own their own docks and freight terminals, while relatively small shippers are accommodated at five public-use terminals constructed by the T.V A Until sufficient experience is gathered to establish fair rates, these terminals will be operated by the T V A.

Flood Control Operations. The reservoirs which were in existence during the last three years have frequently been operated specifically for flood control purposes. A large flood occurred during December 1942 and January 1943. Operations of three large tributary dams and two main river dams which, at that time, were in existence above Chattanooga, a flood danger point on the Tennessee River, reduced flood heights by about 4 ft. The amount of damages averted in this one operation was estimated at about 35 lakhs of rupees During the fiscal year ending June 30th 1944, the reservoirs were operated to reduce flood heights at Chattanooga on three different occasions In the largest flood the reduction in flood heights amounted to some 6 ft During the fiscal year 1945 no major floods occurred on the Tennessee River, but on several occasions minor flood stages were reduced from three to six feet During the severe March 1945 floods on the Ohio River, T V.A. reservoir operations reduced flood heights sufficiently to prevent over-topping of a fuse-plug levee on the Mississippi River, which would have been over-topped if T.V.A dams had not been in existence. During these three years three dams had been placed in operation on the tributaries, and two dams on the main river, of which one was located above Chattanooga.

Power Operations: Along with the growing navigation use of the river and the frequent operations for flood control of the reservoirs, the T.V A power plants generated 9,056 million KWHrs in the fiscal year ending June 30th 1943 ; 10,118 million KWHrs in fiscal 1944 and 11,454 million KWHrs in fiscal 1945 These figures will take on added meaning when compared with energy generation in India For example, for the year 1943 the total amount of energy generated by public utilities in India, including Indian States, amounted to about 3,578 million KWHrs or about one-third of the amount generated in 1943 by the T.V.A alone.

During the three year period from the beginning of fiscal year 1943 to the end of fiscal year 1945, the total installed generating capacity at T V.A. plants increased from 1,375,000 KWs to 2,202,000 KWs This compares with the total installed generating capacity of 1,251,000 KWs in all India, as of January 1st 1944.

T.V.A. power in July 1945 was distributed by 91 Municipal and 46 Co-operative systems over an area of about 80,000 square miles, or roughly one-twentieth the area of India Public distribution of electric power has been accompanied by a vast increase in the number of residential, commercial and industrial power consumers. For example, in 1933 the number of residential consumers in the area served by T.V.A. power was estimated at about 250,000 whereas at the close of the fiscal year 1945 the number was more than doubled to 520,000. The increase in commercial and industrial users was equally impressive, and the total of all residential, commercial, industrial and other consumers at the close of fiscal year 1945 was well over 600,000 During fiscal year 1945 the average residential consumer used approximately 1,750 KWHrs. in the T V A area, which compares with an average use of slightly less than 1,200 KWHrs in the average home in the United States The average use per consumer in 1933 in the United States as well as in the Tennessee Valley was about 600 KWHrs , in other words, in the T.V.A. area the average consumer used three times as much electricity in 1945 than in 1933 and his total bill remained practically unchanged, whereas in the United States as a whole, the average consumer used twice as much electricity in 1945 than in 1933 but his total bill increased by 25 per cent It would seem permissible to draw the conclusion that a cheaper rate of electricity induced greater use.

During the war years, about three-quarters of the electric energy output went to production for war purposes, including large amounts of energy used at one of the atomic energy projects, which was located in the Tennessee Valley, primarily because of the availability of T.V.A. power In fiscal 1945 T.V.A produced more electricity than any other single integrated system in the Nation It has also been estimated that the Tennessee Valley produced one-tenth of all the power produced for war purposes by all the public and private power systems in the United States

T V.A. power is sold under contractual agreements to neighbouring utilities, industrial and commercial concerns as well as to the municipalities and co-operatives who distribute T.V A. power to residential consumers.

Under provisions of the T V.A. Act preference of power sales is to be given to agencies who distribute power on a non-profit basis, such as States, Counties, Municipalities and Co-operatives. Standard T.V.A. re-sale rate schedules are made a part of the contracts, with such agencies and a clause is included that any surplus funds accruing from the re-sale of electricity can only be used for return of indebtedness, betterments or extensions of the system or rate reductions.

Contracts with utilities for power which is to be re-sold for a profit generally include a five-year cancellation clause.

The aim of these provisions which recognise the prior right of the public to sources of public power supply, is to promote the greatest use of electricity at lowest possible costs. Another important principle involved is that surplus funds from the sale of electricity should not replace tax funds. It must also be remembered that large utility or manufacturing concerns are in a better position to construct their own source of power supply than the smaller municipalities and counties.

FINANCIAL ASPECTS

Cost Allocations For cost accounting purposes the investment in T.V.A. multi-purpose projects is allocated to the several purposes served This investment falls in two classes :—

(i) Direct investment for specific purposes, such as navigation locks and power generating equipment ,

and (ii) Investments for facilities which serve several purposes, such as the dam structures and the reservoirs

The direct investment is charged directly to the purposes served The common, or joint investment is allocated among the purposes served in proportion to the cost of construction of each purpose separately.

Of the Authority's major purposes, navigation, flood cntrol and power, the latter is the only income producer. As on all other rivers in the United States, flood control and navigation costs are chargeable to the Federal Treasury. However, by carrying its fair share of the common costs, power assists in liquidating the cost of flood control and navigation as requred in the T.V.A. Act Generally about three-quarters of T.V.A 's total investment has been charged to power.

Return on the Investment: For the fiscal year 1943 gross revenues from power sales amounted to about 10½ crores of rupees, resulting in a net power income of 4·6 crores of rupees, after deductions for operating expenses, payments in lieu of taxes, and annual depreciation. This net return amounted to about 4·8 per cent of the 97 crore average net book value assignable to power during the year

The gross revenue from power during the fiscal year 1944 amounted to 11·8 crores of rupees. The net revenue amounted to 4 9 crores or 4·1 per cent of the 119 crores average power investment during the year, after deductions for depreciation.

In fiscal year 1945 gross power revenues amounted to 13·1 crores, resulting in a net revenue, after all charges, of 6·2 crores, or 4·8 per cent of the 130 crore average net book value of power investments during the year.

Financial aspects of the agencies which distribute T V A power, that is, the Municipalities and Co-operatives, fall outside of the scope of our discussions. I will therefore only state that during 1945 these systems enjoyed an average rate of return, after all charges, but before interest payments, of over 10 per cent of the average net investment in electric plant during the year

Taxes Amongst the most baseless charges, but one which is often repeated, is the canard that "the T V.A. pays no taxes". I mention this because I have already heard this charge repeated here in India, and I welcome it as an old friend. In the United States there are generally two kinds of taxes, namely

(a) State and County taxes ;

and (b) Federal taxes

With regard to State and County taxes, it can be quite simply stated that the payments to the States and Counties, in accordance with the provisions of the T V.A Act, exceed in total amount the tax payments made on the same properties when they were in private ownership, including ad valorem property taxes, excise taxes and business taxes

The criticism with regard to non-payment of Federal taxes amounts to nothing more than a play on words. The amounts paid by Utility Companies for Federal income taxes are a certain proportion of their net income. The T.V.A , a Federal agency, is, as such, exempt from Federal taxation ; however, in accordance with the Act, the T.V.A. pays its entire net income, and not just a portion of its income, to the Federal Treasury. Whether this is called "Taxes" or whether it is called by any other name, does not make any practical difference.

All net income thus far earned by the T.V A. has been re-appropriated to be used for the construction of T V A.'s projects and the amount of new appropriations for projects has therefore been reduced by the total amount of T V.A.'s earned income

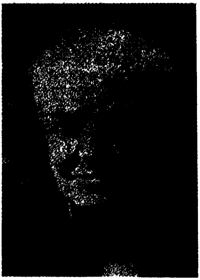
Meanwhile, too, the individual tax-payers, within the T V A area, have been saved substantial payments on account of the reduced charges for electricity, or perhaps a better way of saying it is that they have enjoyed the use of a large amount of electricity for the same monthly payment. They have bought more electric stoves, refrigerators and other electrical equipment which has resulted in a greater increase in manufacturing, retail and service trade in the T.V.A. area than in the United States as a whole. Any tax assessor could probably tell us that increased business brings increased tax revenues I must hasten to add that I realise that it is not customary to gauge increased economic welfare by an increase in tax revenues ; I am saying this only because we are talking about taxes.

(To be continued)

THOMAS ALVA EDISON (1847—1931)

S. N. SEN

THE first birth centenary of Thomas Alva Edison fell on February 11, 1947 The scientists all over the world celebrated this day as a mark of respect to the hallowed memory of one of the greatest inventors the world has ever seen The life and work of this amazing man has inspired generations of scientists and inventors in their effort to utilize scientific discoveries for the benefit of mankind. Mr Henry Ford once remarked of him : "Mr Edison cannot be classed " And so was he—a class by himself, a master inventor and father of modern Applied Research.



Thomas A Edison

Edison is best known to the common man as the inventor of the incandescent lamp and the phonograph. Perhaps these two monumental inventions which so profoundly added comfort to man's living conditions would have been sufficient to earn him a permanent place in the history of science But his life was one of uninterrupted inventions and achievements, and for seventy years that he worked and devised, he tried to make science increasingly serve humanity and contribute to his comforts and material efficiency in thousand ways He perfected the telephone as originally devised by Bell ; invented kinetoscope—the forerunner of cinema projector ; studied the unindirectional conductivity of the space round hot filaments—the so-called Edison Effect, which laid the foundation for later developments in vacuum tubes and radio ; invented the electric pen, the mimeograph, machines for multiple telegraph transmission, the microphone and the megaphone , and achieved thousand such miracles in science, great and small

Edison's inventive genius was equalled by few and perhaps surpassed by none Hiram Maxim, Joseph Swan, and Lane-Fox in America, and Froment, Breguet and Sauerwald, on the continent, were sometimes mentioned as rivals of Edison, but the scientific opinion never doubted his superiority to all other contemporary inventors This was recognized more clearly and unmistakably at the famous Paris Exhibition of 1881, in which he had his 'Jumbo' dynamos, motors, the incandescent lamps and other inventions exhibited He had a sweeping victory and received the highest award, the Diploma of Honour This was communicated to him by a cable which runs as follows "Official list published today shows you in highest class of inventors No other exhibitor of electric light in that class Swan, Lane-Fox and Maxim received medals in class below The sub-jury had voted you five medals but General Congress promoted you to the Diploma of Honour This is complete success, the Congress having nothing higher to give "

Edison was a self-taught genius and gave evidence of inventive powers while still in his teens He is said to have had only three months' training at Port Huron, and then took to the road At 12, he became a railroad newsboy, and after 15, earned his living as a telegraph operator in various cities, always studying and experimenting in his spare time At fifteen, he is reported to have successfully set up, printed and published a newspaper in a running train If he was successful with his newspaper, a similar effort to establish a chemical laboratory in a little-used smoking railway car not only did not succeed, but involved him in serious trouble For, while dabbling in chemistry, he accidentally set fire to the train and had to suffer the unpleasant consequence of being boxed in the ear by an irate railway guard, which, as the story goes, led to his permanent deafness. Edison took an euphamistic view of his deafness and used to say that it enabled him to concentrate on his own problem, undistracted by the noise about him

Edison had to experience enough of such early failures ; but these could never damp his spirits. Before twentyfive, he was already widely known as a successful inventor and was actually the holder of a number of patents One of his early patents was on a stock ticker invented in 1870, which greatly simplified the transmitting devices of the stock ex-

change, and fetched him the significant sum of 40,000 dollars by way of royalty. About 1874, he devised a remarkable little instrument, the electromotograph, which later on found important applications in telegraphy This instrument attracted great attention at the time, and he was invited to demonstrate it at the annual session of the National Academy of Sciences in November, 1874. For this one patent, Edison received more than 100,000 dollars His other inventions in telegraphy include automatic repeater, the quadruplex and printing telegraph, and the sextuplex transmitting idea

Most of his early work and inventions in telegraphy were carried out while he was an employee of the Western Union Telegraph Company. But he soon became deeply absorbed in his own independent programme of research and increasingly found it impossible to continue in the service of any particular company By that time, the income from his patents also assumed a considerable proportion, and he conceived the idea of building himself a research laboratory where he would be free to pursue his own programme of work and devise and invent as he liked Thus came into existence his famous laboratory at Menlo Park, New Jersey, which played a vital role in the subsequent history of inventions and was associated with several epoch-making discoveries in telephony and telegraphy, in recording and reproduction of sound, and in the distribution and utilization of electrical energy for lighting purposes The Menlo Park Laboratory has recently been removed to Mr Ford's Industrial Museum, where it is now preserved as a fitting memorial to the great inventor.

Here, in August, 1877, Edison invented the phonograph as a recording and reproducing machine, which, in importance, was only next to his incandescent lamp. None had thought before of the possibility of reproducing human voice in a machine until Edison showed it. The first message to be recorded and reproduced in the world's first phonograph was a short prosaic sentence—"Mary had a little lamb". It is said that, when on a later occasion in a demonstration before a French audience, he reproduced in his phonograph, a little speech in French thanking his audience, several amongst them left the meeting in disgust, thinking they were being entertained to the performances of a bad ventriloquist.

The phonograph excited great public enthusiasm, and Edison was invited to demonstrate his machine before a meeting of the National Academy of Sciences in Washington The demonstration was a great success. Before a packed hall, the phonograph 'expressed thanks for the honour of being requested to present itself before the Academy'.

Edison's greatest invention, the incandescent lamp, was announced in December 1879, two years after he had taken the world by surprise with his phonograph. His interest in lamps and the general problem of using electricity for purposes of illumination was roused when he accidentally visited the laboratories of one Mr William Wallace, manufacturer of electric dynamos and arc lights, at Ansonia, Connecticut While investigating arc lights and the lighting system, he noticed the very low efficiency of the lamps, and said to Wallace—"I believe I can beat you making electric lights I don't think you are working in the right direction"

Thus he came to take upon himself the task of devising a better and more efficient electric lamp He started his investigations first by undertaking a careful survey of a number of gas lights in several buildings in New York City and the duration of life of such lights According to a recent article in *Science*, by Norman R Speiden, Curator, Laboratory of Thomas A. Edison, New Jersy, this was one of the first market surveys on record After this preliminary survey, he set to work on the problem with his team at Menlo Park Laboratory, working 20 hours a day for months together

It was one of the most thorough investigations ever undertaken by a single laboratory with a perfect team work Glass bulbs of different sizes and shapes were blown in large numbers, their vacuum problems studied, and experiments performed to find the best system of wiring and fuses. Then came the search for an ideal lamp filament. An intensive investigation on the oxides of rare metals such as those of titanium, zirconium, barium, were conducted with a view to ascertaining their suitability as coating on fine hair-like wires Even boron and chromium refractories were tried Having failed in all these elements, he turned to carbon as a probable material for his filament Paper and tissue coated with tar and lampblack were carbonized, and their filaments were tried without much success In his search for a proper material he carbonized a sewing thread and, to his great satisfaction, found it suitable.

On October 21, 1879, he prepared his first successful incandescent lamp which burnt continuously for 40 hours Recording his first trial experiments with his carbon filament lamp at his Menlo Park Laboratory, Edison wrote.

> "We turned on the current. It lit up, and in the first few breathless minutes we measured its resistance, and found it was 275 ohms—all we wanted. Then we sat down and looked at the lamp We wanted to see how long it would burn. The problem was solved if the filament would last. The day was—let me see—October 21, 1879. We sat and looked, and the lamp continued to burn, and the longer it burned the more fascinated we were. None of us could go to bed, and there was no sleep for any of us for forty hours."

Following this success, Edison gave a public demonstration of his lamp at Menlo Park on 31st

December There was a great rush and special trains were run from New York and Philadelphia to Menlo Even during the first spar of his success, Edison was fully alive to the limitation of his carbon filament and immediately began his search for a more durable filament One by one various carbonaceous materials, including coconut hairs, grasses, canes, wood cellulose, and hairs from the beard of one of his associates, were carbonized and tried Finally, early in 1880, he tried a bamboo fibre and found what he looked for.

The first commercial installation of his incandescent light was made on the steamship *Columbia* At first sceptics doubted the success of such installation and many openly declared that it would fail before she rounded Cape Horn. For fifteen years, however, the original installations continued to be in operation without giving trouble of any serious description.

It was the discovery of the electric lamp which led Edison to organize the first Public Electricity Supply Service, which plays such a great part in modern life The whole decade after 1879 was devoted to the invention of methods for generation and distribution of electric light, later of electric heat and power. Improved dynamos and motors, underground mains, three-wire systems were all invented in this decade, and the first electric tram began to run through New York. Thus Faraday's dreams were fulfilled fifty years after the discovery of the 'Law of Electromagnetic Induction'.

His inventive mind always turned to new problems He devoted nearly ten years from 1900 to 1910 to finding out a better substitute for the lead accumulators and succeeded in inventing the Edison Cell, now a familiar accessory in all physical laboratories, in which an alkaline solution, with nickel hydrate as positive and iron oxide as negative material, is used But it must not be thought that success did always come to him *e g*, he spent long years in trying to replace paper by thin nickel foils, and printing on them electrically. If successful, this would have revolutionized the art of making books, as big volumes could be compressed to very small sizes, without reducing the size of types.

Edison's experiments on the effect of a metal plate on incandescent filaments deserve more than a passing notice Briefly, he introduced (1885) a small metal plate in between the straight parts of the carbon filament inside the bulb and noticed the flow of a current when a galvanometer was connected to the plate and the positive of the filament. Known as the Edison Effect, this observation was the precursor of modern vaccum tubes Edison did not quite realize the importance of his observation, although it was patented as usual Twenty one years later, J. Ambrose Fleming, the scientific consultant to the Edison concerns in London, developed the idea and produced the first simple detector tube for radio, which was further advanced when, two years later, Lee De Forest introduced the grid

Edison died in 1931 He was not a great scientist in its proper sense, but was undisputedly one of the greatest inventors of the world. He had no academic training; but whenever he required any scientific information, he always looked for the best and the most authoritative source. When people congratulated him on his genius, he would sometimes burst out. "Genius! why it is one per cent inspiration and ninety-nine per cent perspiration!" He was often heard to remark—'work, and bring out the secrets of Nature and apply them'. In his 'Discovery, or the spirit and service of science', Sir Richard Gregory wrote of him 'Thomas A. Edison is the embodiment of the method of specialized research with a practical purpose. By quickness of perception, fertility of resources, and persistent trial of everything until the best means of achieving his end has been found, he has become the leading inventor in the world.'

U S CHEMICAL SOCIETY AWARD SCHOLARSHIPS THROUGH UNESCO

Ten chemistry scholarships for scholars, chemists and chemical engineers, total value \$25,000, are being offered by the American Chemical Society, for which preliminary selection of candidates will be made by UNESCO (Dr Joseph Needham, Section of Natural Sciences, 19 Avenue Kleber, Paris). Candidates, after completing their studies in the U.S A, will be required to spend a further two years studying in their own countries Further schemes for promoting educational, scientific and cultural activities, principally in war devastated countries, are to be provided for by an international fund of approximately £25 million.

Notes and News

NATIONAL CHEMICAL LABORATORY

THE foundation stone of the National Chemical Laboratory was laid in Poona, on Sunday the 6th April, 1947, by the Hon'ble Dr B G. Kher, Prime Minister and Minister for Education of the Government of Bombay The ceremony was presided over by the Hon'ble Sri C Rajagopalachari, Member for Industries and Supplies, Government of India, and President of the Council of Scientific and Industrial Research A large gathering of over 2,000 distinguished scientists, representatives of industry, and eminent men and women from different parts of India attended the function Over 140 messages of goodwill were received from all over the country from different persons and organizations, including the Hon'ble Pandit Jawaharlal Nehru, Vice President, Interim Government of India, His Excellency Sir John Colville, Governor of Bombay, and the Hon'ble Dr John Matthai, Member for Railways and Transport, Government of India The Hon'ble Pandit Jawaharlal Nehru in his message said

"The establishment of the National Chemical Laboratory is an event of considerable importance for the development of scientific research in India Original work in chemistry is the foundation of national industrial progress and I hope that the new institution of which the Hon'ble Mr B G Kher is laying the foundation will make its full contribution to the development of our material resources The chain of laboratories established under the auspices of the Council of Scientific and Industrial Research will, I trust, give Indian scientists the opportunity of welding themselves into a band of devoted, selfless workers determined to raise India's millions and free them from material, economic and social bondage."

In his address, Sir Shanti Swarup Bhatnagar, Director of Scientific and Industrial Research, traced the history of the work of the Council for the organization of Scientific and Industrial Research and for the establishment of the National Chemical Laboratory. He said:

"This is the fifth laboratory in the chain of a series of National Laboratories which the Council of Scientific and Industrial Research has sponsored . . These laboratories, as I have said before, are not intended to supplant but to supplement the work of individual or collective industrial concerns in respect of research. They will undertake work of the kind that does not come ordinarily under the purview of the existing industries or universities. One of the main functions of the National Chemical Laboratory will be to bridge the gulf between scientific research and its application to problems of human welfare. The National Chemical Laboratory will undoubtedly take up long-range problems of fundamental research in chemistry—problems which are usually not tackled in the universities for want of funds or lack of facilities for organized co-operative research. Such problems are not sponsored by ordinary industrial organizations as their solution does not hold out prospects of bringing immediate monetary advantages to the industries concerned inasmuch as they must be preceded by pilot plant investigations Very often the developmental stages involved, require work of high quality and originality and the expenditure generally is much higher than that involved in the discovery of the fundamental principle India must realize that this developmental work deserves to be recognized as well as the discovery of a principle Perhaps the most attractive and useful feature of the National Chemical Laboratory will be that it will be equipped and organized to meet the needs for such developmental work for which hardly any laboratory in India is at present equipped Such work has been almost completely neglected so far by the universities in India"

The Hon'ble Sri C Rajagopalachari then addressed the audience in which he emphasized the importance of scientific research for industrial development and at the end requested the Hon'ble Mr B G. Kher to lay the foundation stone After laying the foundation stone, the Hon'ble Mr B G. Kher addressed the audience and declared the foundation stone to be well and truly laid

We have already published details of the plan for the National Chemical Laboratory and have also editorially commented on it We understand that Dr S Siddique, Assistant Director of the Council of Scientific and Industrial Research, has been appointed Director of the Laboratory An extensive area of about 470 acres has been secured on the Pashan Road for building the laboratories. The Laboratory will have seven main divisions, each devoted to one of the following subjects Inorganic and Analytical Chemistry , Physical Chemistry including Electrochemistry , Organic Chemistry ; Chemistry of High Polymers , Biochemistry and Biological Evaluation ; Chemical Engineering ; and Survey and Intelligence. Two more divisions are also under contemplation, *e g*, a Division for Fermentation Technology, and another for Cellulose and Related Products The total number of staff to be employed in the N.C.L. will be 320. The capital expenditure has been estimated at about Rs 35 lakhs, and the recurring expenditure is expected to lie between Rs. 10 to Rs 11 lakhs. It is of great interest to note that the Tata Organization have donated a generous sum of Rs 8·3 lakhs to the Council of Scientific and Industrial Research for purposes of the National Chemical Laboratory.

THE ALL-INDIA MANUFACTURERS' ORGANIZATION

THE seventh annual conference of the A.I.M O was held at New Delhi, on the 14th April last, Sir M. Visvesvaraya presiding. Inaugurating the con-

ference, Pandit Jawaharlal Nehru said, "India has got to be industrialized, and rapidly industrialized" The India of tomorrow would be not merely a politically powerful country but an industrially progressive country Industrial development must bring progress to all, and not to a chosen few "We have to think in terms of the masses of the country. Their standard of living must be raised " We must cover in five or ten years what other countries took generations to do

Referring to the question of scientific research, Pandit Nehru asked what industrialists themselves had done in this regard He recognized that there were some industrial organizations in India which had encouraged scientific research but on the whole "their record is astonishingly and shamefully poor".

In his presidential address, Sir Visvesvarava suggested an annual target of Rs 300 to Rs 500 crores for new industrial investments in the country for the next five years A five-year plan, he said, must be prepared on the basis of this outlay, providing for the necessary governmental organization and agencies required for maintaining the drive For the next few years, one-third of the yearly outlay should be government money A portion of it might be invested in nationalized key or other heavy industries

The working of the plan should be closely watched and stimulated by an economic council, which would advise the Industries Department and keep the industrialists and the business public in close touch with government policies and activities

Sir Visvesvaraya recalled the visit of the Indian manufacturers' delegation last year to the U K, U S A, Canada and other countries and said that firms of consulting engineers, chemists, and other experts in those countries had offered to co-operate in the establishment and operation of industries started in India on reasonable terms, leaving final control in every case in Indian hands In the opinion of the delegation, "there is practically no industry in any part of the world which cannot be established and made a success in India, if the government and the public interest themselves closely in the projects"

MINERAL RESOURCES OF THE CENTRAL PROVINCE

THE need for a national mineral policy, thorough and detailed survey of mineral resources, and for more intensive as well as extensive training in geology and mineralogy, was stressed by Prof. N. P. Gandhi, consulting mining engineer and formerly head of the Department of Mining and Metallurgy, Benares Hindu University, at the C. P. and Berar Industrial and Commercial Conference, held at Jubbulpore on April 20, 1947 Prof. Gandhi particularly referred to the mineral resources of the Central Province and made a strong plea for adequate provision for teaching in geology, mining, and metallurgy at the Nagpur University and for the establishment of a Provincial Geological Survey

He referred to the important mineral resources of the Province, such as manganese, coal, bauxite, iron ore, and building materials Most of the manganese ore, of which India is the second largest producer after the Soviet Union, is mined in C.P As an average for the years 1913-1937, 36 per cent of the world's manganese ore came from the Soviet Union, 28 per cent from India, 9 per cent from Brazil, and 8 per cent from the Gold Coast of West Africa The bulk of the ore comes from the districts of Balaghat, Nagpur, Bhandara and Chhindwara Manganese is an indispensable raw material for the steel industry, and most of the Indian manganese is at present exported in the form of raw ore

Over 150 million tons of coal occur in the C P. in the Wardha Valley, Chhatisgarh and Satpura fields, of which 50 million tons are easily workable The average annual production is about one and a half million tons

Enormous deposits of high-grade bauxite occur in various parts of the C P, notably in the Balaghat, Katni, Mandla, and Seoni districts This light metal has an assured place in the future metallurgy and the bauxite deposits of the C P await the development of transport facilities and cheap electricity Large deposits of high-grade iron ores also occur in C.P, notably in the Chanda and Drug districts and in the Bastar State

The Central Provinces have also got large and widespread resources in various building materials such as brick-clays, kankar, laterite, basalt, limestone, marble, pottery clay, fire-clay, pipe-clay, sandstone, roofing and flooring slates, etc, which can greatly aid her in her industrial development There are also many minor minerals in the C P. such as sillimanite and asbestos in Bhandara, soapstone in Jubbulpore, semi-precious stones in the Deccan Trap and in the Nerbudda, graphite in Betul, lead and silver in Bilaspur, Hoshangabad, Drug and Jubbulpore, and ochres, abrasives, alluvial gold and mineral waters in several districts

Prof Gandhi finally referred to the growing importance of the C.P from the view point of her mineral resources During the year 1938, the Government of India granted 468 licenses for mineral prospecting in the whole of India of which as many as 324 were in the C.P In the same year, the Province was granted 66 mining leases out of a total of 137 for the whole of India.

A CHALLENGE TO SCIENTIFIC WORKERS

On March, 7th in the House of Representatives, Canberra, Mr J. P. Abbott, a Liberal Party Member, in course of an attack on the government, made a number of serious charges and insinuations against the Australian Association of Scientific Workers which is a member of the World Federation of Associations of Scientific Workers. According to the Globe News Agency, Mr Abott is alleged to have remarked that "the A A.S.W was linked with the Canadian A S W., which has been connected with an espionage gang".

The Federal Chairman of the Association, in course of a statement against the insinuations, has stated "the members of the A A S W are qualified Australian scientists The Association is completely independent and autonomous Its objectives are to secure the wider application of science and scientific method for the welfare of society, to promote the interests of science and to maintain the status of the scientific worker In pursuing these objects it will not be deterred by any witch-hunts or scare stories put out for pure political reasons" In a letter written by the Association to the Prime Minister of Australia, the Secretary has stated plainly that the Association "will be glad to provide you or any officer of the government with any further information whatsoever on its composition and activities which you may require "

That science can no more remain unaffected by politics has been amply proved by the attitude of governments of some countries adopted towards matters related to atomic researches If science cannot escape the danger of becoming pawn in the hands of vested interests, less can be scientific workers. After all, scientific workers are more "dangerous" than scientific work, since it is the former who are responsible for the latter

It is heartening to see, however, that the scientific workers are getting united all over the world and they are determined not to meet any intimidation and threat.

PHARMACOGNOSY LABORATORY

We have much pleasure in announcing the establishment of a Pharmacognosy Laboratory by the Government of India (Health Department) located in the Indian Museum (1, Sudder Street, Calcutta).

The importance of pharmacognostic researches in India was visualized during World War II when India felt an acute shortage of imported drugs Researches on the subject unearthed many new substitutes which have been recognized in the pharmacopoeia, and the pharmacognostic characters of the drugs described in the 'Indian Pharmacopoeial List' (published by the Government of India) have been mentioned The essential need for the establishment of this laboratory was further realized by the Government in connection with the formation of the 'Central Drugs Laboratory' (See SCIENCE AND CULTURE, March, 1947, p. 430) and the enforcement of 'The Drugs Act, 1940'

The work of the laboratory includes identification and evaluation of drugs either in crude or powdered form as well as problems of research in finding new substitutes, methods of collection, curing and storage of drugs, the influence of particular age, season and locality regarding the yield of maximum active principles, checking of adulteration of drugs and similar other problems

The problem of cultivation of medicinal plants in India and introduction of foreign drug plants for acclimatization in this country and zonal plantation of medicinal plants are included in the programme of work of this laboratory

MR S. N. BAL: DIRECTOR, PHARMACOGNOSY LABORATORY

Mr S N Bal, Ph C , B.S (Phar), M S (Mich), Officer-in-Charge and Curator, Industrial Section, Indian Museum (Botanical Survey of India), is appointed as the first Director of the newly established Pharmacognosy Laboratory, after his retirement from the former post During his services as Curator, Mr Bal devoted himself to the medicinal aspect of Economic Botany and published several books and papers on pharmacognostic aspects of *senega, kurchi, aconites, lobelia, ipecac, picrorhiza, gentiana, cinchona* etc

Educated in the National Council of Education, Bengal, Mr Bal served for some time at Messrs. Bengal Chemical and Pharmaceutical Works Ltd , Calcutta and later went to U S A for higher general studies in pharmaceutics He obtained diploma in pharmaceutical chemistry, bachelor's degree in pharmacy and post-graduate degree with food and drug analysis, botany and bacteriology as special subjects On his return to India, Mr Bal served for sometime as a manure chemist at Messrs. Shaw Wallace & Co. and was later appointed an Assistant Professor of Botany in the University of Calcutta. In 1922, he was appointed Curator, Industrial Section, Indian Museum, from which post he retired on 1st April, 1947

Mr Bal has been connected with the activities of Indian Pharmaceutical Association, of which he was Vice-President. He presided over the first All-India Pharmaceutical Conference in 1941 and lately served

as a member of the Indian Pharmacopoeial List Committee of the Government of India. Mr Bal was elected President of the Botanical Society of Bengal for two years and is one of the trustees of the Indian Museum for a long time.

We hope that, under his able guidance, the Pharmacognosy Laboratory will develop into one of the important and leading centres for pharmaceutical and drug researches in this country.

INDIAN ECOLOGIST

WE have much pleasure in bringing to the notice of our readers the first issue of the *Indian Ecologist*, published under the auspices of the Indian Ecological Society. Its publication has now removed the long-felt need of a suitable organ for focussing attention on the importance of ecology as an applied science for the planning, organization and development of the abundant and unexploited agricultural, silvicultural and pastoral possibilities of India.

The *Indian Ecologist* is edited by Prof. F. R. Bharucha. The first issue contains a number of original articles by experts. In a paper entitled *'The Microclimates of Plant Communities'* by L. A. Ramdas, the author reviews the results on various aspects of micro-climatology obtained at Poona and elsewhere. Observations on the climates of crops and of the 'open' were recorded at Poona for the last ten years. Gaps in our knowledge of local climates, particularly in large plant communities like forests, can be filled in by works of this nature. In a paper entitled *'An Ecological Aspect of Soil Conservation'*, Messrs J. K. Basu and L. Sreenivas emphasize the establishment of 'contour strip cropping' that would develop a protective cover and check runoff, naturally minimizing soil erosion to a great extent.

The ecology of low-lying lands about Benares which hold standing water for different periods in the year is described by R. Misra. An analysis of the vegetation and the habitat reveals that the plant communities, while showing seasonal aspects, are not entirely seasonal for their existence and it is possible to interpret and classify them on the basis of developmental succession. J. F. R. d'Alemeida, by observations in the field and experiment proves that the aerenchyma of floating roots of *Sesbania aculeata* Pers, is produced in direct response to aquatic conditions.

A. K. Mallick (Poona) describes a method for testing the resistance of crop plants to aerial drought, and of the two varieties of sugarcane experimented with, C.O. 421 is a drought-resisting variety.

The journal is now issued twice yearly, but we understand that it will be published soon as a quarterly. We have no doubt that it will act as an useful organ for the co-ordination of ecological research and for dissemination of ecological knowledge.

INDIAN PATENTS

AN exhibition of 'Indian Patents' was organized for the first time in India, by the Lord Reay Maharastra Industrial Museum, at Poona, as a part of its Tata birthday celebrations, during the first week of March, 1947. Opening the exhibition, Diwan Bahadur K. Rama Pai, Controller of Patents and Designs, Government of India, said:

"India had, for a long time, occupied an important position among the chief manufacturing countries of the world, and at one time she was sending manufactured goods to England and other countries of Europe. This was the case not merely in the remote past, but even as recently as 200 years ago. The superiority of Indian products over European manufactured goods was so great that England was forced to resort to protective tariffs against goods of Indian manufacture. But the industrial revolution of Europe in the latter part of the eighteenth century, and the adoption of labour-saving machinery and large scale production methods by the Western countries, completely changed the position to India's disadvantage. And by the middle of the nineteenth century many of the Indian industries were ruined or crippled, as the result of foreign competition."

Continuing, Mr Rama Pai dwelt on the utility of such exhibition, as it would surely stimulate Indian talent and Indian enterprise to develop Indian resources. It would further provide an incentive to inventors and patentees to establish contacts with industrialists. At present, many an invention is wasted for lack of co-operation between the inventor and the industrialist. From the standpoint of the educative value, the most important function of this exhibition should be to focuss the attention of inventors and industrialists upon the patent system and its utility. Patent system has been in existence in this country for more than 90 years but it has least publicity. The number of applications for exclusive privileges or patents received during the year 1946 was 2,610 and of these 90 per cent came from aliens and only 10 per cent originated from Indians.

This exhibition is supposed to be a prelude to the establishment in Poona of a permanent museum of patents on the lines of the British Museum in Kensington.

In an article entitled "Patent Legislation" (*Jour. Sc. Indus. Res.*, December, 1946), Mr Rama Pai suggests the establishment of a *Patent Planning Commission* and a *National Patents Trust* to facilitate the exploitation of patents in the best interests of the country and to make the nation invention minded.

ZOOLOGICAL SOCIETY OF BENGAL

THE first annual general meeting of the society was held on March 30, 1947, at the Zoological Labo-

ratory, Calcutta University, (35, Ballygunj Circular Road) Dr P. Sen, M Sc , Ph D , Vice-President of the Society, presided

Presenting the annual report, the Honorary Secretary, Dr S P. Rai Chaudhuri, stated that the Society held six monthly meetings during the year under review, when reputed Indian and foreign zoologists delivered lectures, dealing with the applied aspects of zoology

The Society has undertaken the publication of a monograph on *Ophicephalus punctatus*, a common teleostian fish, widely used as a type specimen in the zoological laboratories Planning is in progress for research on the control of filariasis for which the Society is promised a donation by Dr P K Sen Gupta (Calcutta)

The Society expressed its grave concern over the proposed transfer to Delhi of the Zoological Survey of India from Benares, where it was temporarily transferred during the war from Calecuta, as the proposed transfer would remove the library of the Survey, and would thus hamper the activities of research workers in Zoology in Bengal The Government were requested to re-consider their decision In the meanwhile, the Society has undertaken the building up of a library of its own and issued an appeal to zoologists in India and abroad for reprints of their works According to this appeal, the zoologists of India and zoologists and zoological societies of foreign countries are requested to send spare copies of reprints of their works and to put the Society's name in their mailing list.

The Society held a scientific session, at which Messrs D Mukerji and P Mitra read a paper 'On the control of mound building termites, *Odontotermis redemanni* Wassmann', dealing with ecological and biological studies on the mound-building termites and their control by the application of toxic chemical substances

The following were elected members of the Executive Committee for the year 1947-48 *President* Prof H K Mookerji , *Vice-Presidents* · Dr S L. Hora and Mr D Mukerji , *Treasurer* Mr G. K. Chakravorty , *Secretary*. Dr S P. Raichaudhuri , *Members* · Mr B K Chatterji, Mr K. N Das, Dr M O. T. Iyengar, Mr N C Law and Mr J. N. Rudra.

BOTANICAL SOCIETY OF BENGAL

The Eleventh Annual General meeting of the Society was held on Saturday, the 26th April 1947, at the Botanical Laboratory Calcutta University, Dr K. P. Biswas, D.Sc., F R S E., a Vice-President of the Society presiding

Presenting the annual report, the Honorary Secretary, Dr P N Bhaduri, said, that five general meetings were held during the year under review, at which both foreign and Indian botanists delivered lectures and read original papers, including illustrated talks on 'Cyto-genetics of *Datura*' by Prof. A. F. Blakeslee (U S.A) and on 'Rust disease in Canada with special reference to wheat rusts' by Dr W. F. Hannah (Canada)

It is pleasing to note that the Society has published the first issue of the Bulletin, (Edited by Dr P N Bhaduri) containing original articles by members of the Society and covering a wide range of subjects, and including the address by the retiring president (Prof S R Bose) on 'Antibacterial action of Polyporin' (See p 544).

The following were duly elected as office bearers for the year 1947-48 *President* · Prof G P Majumdar , *Vice-Presidents* . Prof S R Bose (Ex-officio), Mr S N Bal, Dr K P Biswas, Prof A T. Das Gupta and Prof. P C Sarvadhicary ; *Treasurer:* Mr J C Banerji , *Honorary Secretaries* Dr P. N. Bhaduri and Mr A K Ghosh

Prof S C Mahalanobis, B Sc. (Edin), F R S E , I E S. (Retd), Emeritus Professor of Physiology, Calcutta University and a past-President of the Society was elected an Honorary Member of the Society, in recognition of his pioneer work, for the cause of advancement of biological sciences in India

DIPLOMAS OF THE INDIAN AGRICULTURAL RESEARCH INSTITUTE FOR 1946

The following students of the Indian Agricultural Research Institute, New Delhi, have been awarded the Diploma of the Institute (Assoc. I A R I) after completion in September 1946 to two-year P G Course and acceptance by the Institute Council of the thesis submitted by them as mentioned against each.

Agricultural Botany and Plant Breeding

Narendralal Dhawan : Interspecific hybridization in *Sesamum* L ; S. Bashaiat Ali Shah Colchicine-induced polyploidy in different varieties of chillies (*Capsicum annum*) , V. Ramamurthy . Pt. I Studies in the seed-coat anatomy of *Brassica* sp., Pt. II. Studies on colchicine-induced polyploidy in some Imperial Pusa types of *Sesamum Orientale* L ; Choudhry Mohd Shariff Sardar Khan : Influence of late sowings of wheat on yield and variation in plant characters , Yogendra Mohan Upadhyaya · Variability and the role of natural selection in wheat varietal mixtures and hybrid generations , Shyam Narain

Sharma · Effect of temperature on the development of wheat grain.

Agricultural Chemistry and Soil Science

Khubo Gianchand Tejwani. Effect of nitrogenous and phosphatic fertilizers on soil fertility and crop composition when legumes or either included in, or excluded from the rotation (A lysimeter study)

Entomology

Parkash Lall Renghen Pt I On the morphology of immature *stages* of fruit fly *Dacus Cucurbitae* coq with short notes on its biology, pt II Our present knowledge of the insect pests in India of the important edible fruits of the family Rosaceae, Abdul Maman Pt I The survey of insect pests of dried fruits ; pt II Biology of the saw-toothed nuts beetle *Oryzaephilus mercator* Fauvel, with description and bionomics of one new specis of the genus *Stathmopoda*. Pt III Thorough review on the work done on most important pests of dried fruits, with a separate chapter on control measures, Mohammed Mohsin. Pt I Studies on the role of nutrition in the longevity and fecundity of *Microbracon gelechiae* Astom. A larval parasite of potato tuber moth. Pt. II. A review of the work done in the control of the sugarcane moth borer, *Diatraea Saccharalis* fab. by its egg parasite, *Trichogramma minutum* Riley

Mycology and Plant Pathology

Hari Krishna Saksena Studies in the physiology of *Ustilago Tritici* (pers) Rostrup causing loose smut of wheat

Sugarcane Breeding

Obaidullah Jan Pt I. Sugarcane Breeding with special reference to the work done in Coimbatore Pt. II. Some studies on the influence of the size of the sugarcane setts, location of nodes and the depth of planting on the germination, tillering and final stand of the crop ; Om Parkash Agarwal: Pt. I. The activities relating to the production of Co canes with special reference to the breeding work at Coimbatore. Pt. II. Studies on the effect of photoperiod factor on growth of sugarcane.

TO OUR READERS

In the March issue of "SCIENCE AND CULTURE" a questionnaire was circulated to all its readers for ascertaining their opinion regarding proposed changes in the journal We acknowledge with great pleasure the ready response shown by the readers from all corners of the country Answers to the questions evinced the sympathy of the readers towards the journal as also their wide interest in the varieties of subjects The journal will endeavour its best to cater to the needs as desired

The members in general have agreed to the proposal for enhancement of the rates of subscription and advertisement In accordance with the suggestions received, and with reluctance on the part of the Board of Editors, the annual *inland* and *foreign* subscriptions of the journal will be increased to Rs 10/- and £1, respectively, from July next The price of each issue, *inland* and *foreign* will be similarly increased to Re 1/- and 2 Shillings respectively

Changes in the rates of advertisements have been communicated to our advertizers who co-operate with the subscribers to keep "SCIENCE AND CULTURE" alive.

ANNOUNCEMENTS

THE Government of India have appointed a 'Scientific Manpower Committee', to assess national requirements for different grades of scientific and technical personnel during the next ten years and to recommend steps to be taken during the next five years to meet these requirements

The Committee consists of Dr Sir Shafaat Ahmed Khan, (*Chairman*), Dr H J Bhabha, Sir S S Bhatnagar, Dr K A. Hamied, Mr Afzal Hussain, Col K H James, Prof Humayun Kabir, Rai Bahadur A N. Khosla, Sir K S. Krishnan, Mrs Hansa Mehta, Mr G L Mehta, Prof J N Mukherjee, Dr M. D. Qureshi, Prof. B Sahni, Wing Commander H Singh, Mr D N Wadia and Dr S. R Sen Gupta (*Secretary*)

The Committee is to report within six months and is expected to meet early in May.

AT the Annual Convocation of the Forest Research Institute and Colleges, Dehra Dun, held on 31st March 1947 and presided over by the Hon'ble Dr Rajendra Prasad, Member for Agriculture and Food, Government of India, Mr A. C. Dey, of the Chemistry and Minor Forest Products Branch, was awarded the "*Howard Medal*—1946" for his meritorious research work on *Ocimum*. This award is made every year for the best contribution to the advancement of research at the Institute by a member of the technical staff

SCIENCE IN INDUSTRY

RESNATRON

INFORMATION has now been released of the development of a new high-frequency generator tube, the Resnatron, which was successfully used for jamming German radar during the allied aerial offensive Originally developed for military use, the resnatron is expected to have many important peace-time applications in connection with frequency-modulated radio and television and long distance high frequency communications

The idea of a high frequency generator tube was conceived in 1938 by Dr David H Sloan, associate professor of erectrical engineering, who designed the world's first million-volt X-ray tube in 1922 His original intention was to build a high-frequency tube which could be used in a big powered electron linear accelator At that time, the pulsing techniques of radar were quite unknown and there was no method for obtaining ultra-high frequency of continuous wave power needed for such an atom-smasher In 1940, Dr Sloan built his first successful resnatron which produced 70 kilowatts at about 860 megacycles The usefulness of resnatron as a radar counter measure device was realized quite early and since 1940, O.S.R D undertook further research on this device

Unlike the magnetron which, in radar, transmits ultra-high frequency power in short bursts, the resnatron pours out continuous wave power It makes use of the principle of 'explosive burst' firing of electrons from the cathode Electrons emitted from filaments in the tube are fired in bursts from the cathode through a focussing grid arrangement across a gap to the anode resonator where they transfer their energy into the radio circuit which conveys power to the radio antenna.

The resnatron was one of the first tubes in which the traditional coil was replaced by a resonant cavity. Its another major innovation was the correlation of the time required to cross the gap and the shift in phase of the voltage to permit the voltage in the anode of resonant cavity to go through its minimum value just when the electrons arrive, thereby wasting the least power.

The resnatron is claimed to be one of the most powerful and efficient sources of stable power amplification. In ultra-high frequency operations, it has achieved the same efficiency of a high frequency radio-broadcasting station—about 80 per cent As a counter radar device, resnatron successfully jammed German radar as far out as 300 miles, as high as 30,000 ft., and for a breadth of about 15 miles It was particularly successful for frequencies between 350 and 600 megacycles

Work on resnatron is still in progress Recently the Westinghouse Laboratories have developed an improved form of resnatron, having the highest output of 140 kilowatts at 450 megacycles It is believed that before long resnatron will find application in television and frequency-modulated radio.

TRIOXANE—A PLASTICIZER, FUEL AND SOLVENT

TRIOXANE a polymer of formaldehyde useful as a fuel, solvent, plasticizer, intermediate in organic reaction processes, and for a wide variety of other industrial purposes, is now available for commercial distribution according to an announcement made by the E I. Du Pont de Nemours & Co.

Trioxane, a colorless, plastic, crystalline solid, has a sweet odour, not unlike that of chloroform, and has no trace of a formaldehyde odour The product ignites instantly and burns with a very hot, non-luminous, clean, odourless flame, a property suggesting its possible use as a packaged fuel for campers, picnickers, hunters, and industrially, wherever a packaged fuel is required

Readily soluble in alcohols, ketones, ethers, esters, chlorinated hydrocarbon solvents and aromatic hydrocarbons, trioxane, in molten state, is itself a solvent for many organic substances, including phenol, naphthalene, vegetable oils, fatty acid amides, urea, and, in the presence of water, the protein, zein. Where its volatility is not objectionable, these properties suggest the possible use of trioxane as a plasticizer of other materials. Trioxane-zein compositions, for example, are believed to present many potential applications in coatings and as plastic aggregates.

The solubility of trioxane in most types of organic materials makes its use possible as an intermediate in organic reaction media. In such anhydrous media, the product is stable if the system is neutral or alkaline. Small amounts of strong acids or acid-forming substances cause the compound to depolymerize to monomeric formaldehyde at a rate that may be controlled by regulating the catalyst and temperature.

ALUMINIUM CHLORIDE CATALYST FOR HIGH OCTANE PETROL

DURING the war, the Shell Development Company of California developed a new catalytic process for the production of high octane spirit which greatly helped to tide over the problem of shortage of high octane petrol (*The Chemical Age*, February 15, 1947) The new catalytic process changes the straight-chain petroleum products to branched-chain compounds and thus enables the conversion of butane into isobutane.

Aluminium chloride is used in the new catalytic method. The catalytic activity of anhydrous aluminium chloride for hydrocarbon isomerization at low temperatures was, however, known in the laboratory for a long time But the commercial application of the method was frought with several difficulties which had to be overcome with great care For instance, if the chemical reaction was to be carried out in a gaseous state, aluminium chloride vaporized in some parts and solidified in others, thus blocking the apparatus in those parts. The possibility of conducting the reaction in a liquid state was also suggested, but the solubility of the catalyst was not great enough to make this reaction practically feasible.

A way out of these difficulties was found by the Shell Company, which developed a vapour-phase process for butane isomerization, using aluminium chloride impregnated on a bauxite carrier. The process lent to widespread commercial application with success Meanwhile, work on the liquid process was also continued and was developed, which could also be applied for large scale conversion of butane.

Researches in the laboratories of the Shell Development Company indicate that aluminium chloride dissolved in antimony chloride together with hydrogen chloride is the best catalyst for the purpose The new process is reported to have a constant high conversion with attendant low catalyst consumption At present, a number of commercial plants are in successful operation

SELECTIVE ELECTROPLATING

B K CHOUDHURI,

ORDNANCE LABORATORIES, CAWNPORE, U P

MODERN engineering designs require localized properties such as appearance, hardness, friction resistance, chemical inertness etc. on parts of machines or on articles Fabrication of such parts of machines entirely of metals or alloys with required properties may not be feasible Besides this, considerations of general strength of the part or of economy of production might militate against such an idea As a result, such parts are generally covered with particular metals or alloys upto a thickness consistent with its performance characteristics The process of electrodeposition of such metals or alloys locally on parts of machines or on articles is known as selective electroplating The process is utilized in multiple ways in present day manufacture of various kinds of articles.

The rich colour of gold is very pleasing to the eye in addition to the noble chemical behaviour but the cost prohibits the use of gold in the manufacture of articles entirely with this metal Gold can be selectively electroplated over the surface of an article made of a different metal The metals platinum, iridium and rhodium are well known for their high resistance to chemical attack The electrodeposited platinum is extremely hard Parts of mechanical or chemical plants requiring protection against abrasion, chemical attack or properties of catalytic action of the above metals may be selectively plated with these metals

The alloys of lead with silver, tin or copper have high performance of high load bearing properties, but they lack the strength of steel These alloys are selectively electroplated on the bearing surfaces of steel or bronze. Some of these alloys cannot be produced by ordinary melting process even

Chromium is a hard metal, highly resistant to corrosion both at high temperature and chemically. Moreover, the friction both static and sliding of chromium against chromium surface is known to be lowest amongst metals Chromium is selectively plated over steel bearing surfaces or inside engine cylinders and over pistons to impart these properties. The hardness of electrodeposited chromium is more than one and a half times in magnitude than the hardest steel Chromium is selectively deposited on cutting faces of borers, reamers, milling machine tools, dies, gauges etc. to increase their life and to impart other properties

The selective electroplating is used in other ways also The hardness of iron can be increased by increasing the carbon content to bring up the structure

and composition of steel. When this property is to be localized selective electroplating with copper on portions to be maintained as soft iron is carried out before the articles are given the case hardening heat treatment Thus 'Gear' blanks are generally made of mild steel for ease in hobbing and other machining The tooth portions only are case hardened, leaving other portions soft. Nitriding of steel produces intense hardening of the surface In order to localize the effect, the remaining portions are electroplated with tin or bronze which has no penetrability by the nitriding atmosphere even at the high temperature of 1000°C.

Adhesion of rubber is better on brass or zinc surfaces. In order to insulate portions of electric instruments, such portions can be selectively electroplated with brass or zinc, before rubber dough is spread on and vulcanized.

Worn parts of machines, undersize shafts and worn motor parts which are very costly can be reclaimed by selective electroplating

The technique of the selective electroplating depends largely on substances which are to be used as stopping off medium for portions of the article where no plating is desired in addition to the baths from which deposition of metals and alloys are to be made and the thickness of the deposit which will be suitable for the particular purpose

The most important article for selective plating is the stopping off medium The success of the plating depends on it to a great extent Its failure might cause serious loss This is particularly so in the case of nitriding and case hardening heat treatments If a spot is left without plating on an article where softness is desired, hardness will result after heat treatment This will cause not only difficulty at the time of final grinding but will lead to fatigue failure Similarly softness can appear on portions to be hardened if plating appears at spots leading to the same result.

Stopping off compounds are generally insulators of low melting point, which will not react chemically with the plating solutions When molten, these must thoroughly wet the metal surface The parts where no plating is required are stopped off with molten compounds and then the articles are taken through the pre-treatment cycle consisting of (*a*) degreasing in hot alkaline solutions, (*b*) washing, (*c*) acid dipping and finally plating in alkaline cyanide solutions or acid solutions for much longer time than in the preliminary processes The effect of these solutions on stopping off compounds is very adverse The cyanide plating solution is a very strong detergent and a few stopping off compounds resist its action and properly blanket the portion to be stopped off The chromium plating solution has a very strong oxidizing property and a few of the stopping off compounds can stand upto it. Previously, various waxes or mixtures of wax were extensively used but the development of vinyl chloride plastics, styrene plastics and chlorinated napthalenes have produced the most suitable substances for use as stopping off compounds Rubber can be used for the purpose but with certain limitations It cannot be used in chromium plating due to the strong oxidation by chromic acid which causes rapid deterioration of rubber Adherence, ease in removal, non-toxicity in handling are the main criteria for the ideal stopping off compounds The synthetic resins are considered most suitable because these are tough, resilient, flexible and can stand rough handling In order to obtain suitable properties, these resins can be mixed up with various plasticizers Such compounds can be formulated to give either an envelope only or a very adherent coating The application of the stopping off compound is made either by dipping, brushing or spraying Care must be taken to avoid formation of air bubbles between the surfaces of the article and the coating The coating material must dry thoroughly before the articles are taken up for pre-treatment operations for plating This involves proper choice of solvents and use of hot chambers Since the synthetic coating materials are very inactive, chemically powerful solvents are generally used For the easy removal of the stop off coating, it is desirable to choose thermo softening type of materials Removal of the stop off coating from the places where plating is to appear should be done with knife blades. Any defect appearing during this trimming operation must be carefully repaired.

The electrodeposition of metals and alloys from solutions demands constant attention to the maintenance of the composition of these solutions, their particular temperatures and the control of the electric currents flowing A slight variation in any of these factors will affect the property of the deposits. The nature of the deposit may vary from non-porous and very finely grained crystalline deposit to powders of metals and alloys. To obtain the most suitable deposit, it is necessary to have a complete knowledge of the characteristics of the solutions used and the effects of the change of the constituents of the solutions The constituents of a plating bath are generally

(1) salt of the metal to be deposited ;
(2) conducting salt to increase the conductivity of the bath ;
(3) buffer salts to maintain *p*H of the bath within a suitable range ; and
(4) addition agents to enhance certain properties of the deposit, *viz.*, finer grain, brightness, hardness, etc for the prevention of pitting, nodular deposit etc.

In order to increase the rate of deposition, the salt of the metal should preferably be chosen in such a way that the metal is deposited in its lowest valency state In order to maintain the conductivity which, on the contrary, depends on the metal ions and anions, the conductivity salt must have the property of bringing the soluble anodes into solution through ionic action If insoluble anodes are used, metal salts should be added at frequent intervals to maintain the composition within suitable range This range should be very wide so that uniform nature of the deposit can be obtained under varying concentrations In electro-deposition process, the maintenance of the *p*H of the solution is most fundamental. Metals and alloys are generally deposited within a range of *p*H value characteristic to them Working of the solution beyond this range may not produce any metal or alloy deposit at all Besides this, *p*H value of solutions has great influence on the appearance to the deposit and its adhesion to other metals. The conducting salts have sometimes great influence on throwing power or the capacity of the solution to deposit at any point of a highly deformed object This is especially seen in the case of chromium deposit On the maintenance of a correct ratio of chromic acid to sulphate ions depends whether entire portion of a flat object bent at right angles will be covered up with plating or not.

In the following the constituents of modern plating baths are described

Copper Plating Copper plating is done from both alkaline and acid baths Due to the action of acid on ferrous material, acid copper bath is not suitable for direct deposit on iron and steel articles. The current efficiency of the acid bath is higher than the alkaline bath and, as a result, thicker deposit is obtained for equal charge flowing through the baths

The acid bath contains copper sulphate and sulphuric acid Glue, gelatine or phenol is used in small quantities as addition agents This bath is highly suitable for electroforming purposes also

The cyanide bath in general contains cuprous cyanide, sodium carbonate and sodium cyanide To improve cathode current efficiency, sometimes rochelle salt is added To produce brightness of the deposit, sodium sulphite, bisulphite, thiosulphate or piperonal is added in small quantities Addition of sodium plumbite is sometimes made to increase brightness and particularly for producing fine grain deposits Recently, Du pont company of America have patented a high efficiency solution containing higher concentration of cuprous cyanide, lower free cyanide and higher sodium hydroxide content The solution is worked at a higher temperature 75°—85°C To increase brightness, sodium thiocyanate has been used and to prevent pitting in the deposit, betaine—a cyclic amine, has been used This bath takes a current as high as 15—20 amps per sq. ft at a cathode efficiency of 100 per cent.

Silver Plating Silver plating is done from cyanide baths containing silver cyanide, potassium cyanide, potassium hydroxide and carbonate. Sodium thiocyanate or ammonium thiosulphate is used in small quantities as brightners Urea is used to produce a hard deposit, hydrogen peroxide is used as an antipit agent

Gold Plating: Gold plating is also done from cyanide baths containing gold cyanide, potassium cyanide, disodium hydrogen phosphate and potassium carbonate For very heavy deposits of gold, hydrochloric acid and gold chloride bath is most suitable.

Nickel Plating Nickel plating is done from either nickel ammonium sulphate bath or nickel sulphate bath The bath containing nickel ammonium sulphate gives thinner and harder deposits and is generally used for plating mixed metals like brass, bronze, etc The nickel sulphate bath has higher current density limits and is most suitable for rapid plating for thickness In addition to the above salts, nickel bath contains nickel chloride for anode corrosion and boric acid for the maintenance of the *p*H of the baths within proper limits Modern developments of bright nickel plating bath is based on nickel sulphate bath to which different amounts of cobalt sulphate is added to give bright deposits of nickel and cobalt alloys Sometimes the brightness is produced with the addition of formaldehyde, cadmium salts, zinc salts, aryl sulphonic acids, ketones, amino-polyaryl-methanes in small quantities The amount of these chemicals must be controlled very critically

Chromium Plating Chromium plating is done with a bath of a highly pure chromic acid containing only one per cent sulphuric acid. The presence of an amount lower or higher than one per cent of sulphuric acid decreases the throwing power of the bath Temperature higher than 50°C and presence of 20 grams per litre of trivalent chromium in the bath favour the deposition of soft chromium which can be machined

Cadmium Plating Cadmium plating is done from an alkaline cadmium cyanide bath containing cadmium oxide dissolved in sodium hydroxide and sodium cyanide Nickel cyanide is added in very small quantities to brighten the deposit Brightness of the deposit and finer grain can also be produced with certain colloidal matters. Turkey red oil is often used in the cadmium bath for this purpose.

Zinc plating: Zinc plating is done from both acid sulphate and alkaline cyanide bath. The rate of deposition in the acid sulphate bath is higher. The cyanide solution is used for plating on ferrous materials The bath contains sodium zincate, sodium

cyanide, sodium hydroxide and sodium carbonate Various addition agents are added to brighten the deposit. Some of these at the same time increase the current density limits and the tolerance for impurities, and improve throwing power.

Tin plating Tin plating is also done from both acid sulphate and alkaline stannate bath. The rate of deposition in the acid sulphate bath is higher The stannate plating bath has the highest throwing power among all plating baths. The bath contains sodium stannate, sodium hydroxide and sodium acetate. Sodium stannite is formed if anode does not corrode properly Hydrogen peroxide is added occasionally to convert any stannite formed into stannate For the maintenance of the bath, care must be taken to see that anode corrodes as stannate salt

Lead Plating Lead plating is done from acetate, sulphamic or lead fluoborate bath The latter solution is widely used because its current efficiency is about 100 per cent Glue is used as an addition agent to improve the nature of the deposit and to present nodular growths

Platinum Plating: Platinum plating is done from alkaline platinate solution containing sodium hexhydroxy-platinate, caustic soda, sodium oxalate and sodium sulphate. Platinum-diammino-nitrite solution containing ammonia nitrate, sodium nitrite and ammonia is also used But the former solution can be used to build up any thickness

Palladium plating: Palladium is plated from sodium palladium nitrite and sodium chloride bath with metallic palladium as anode When very high thickness is required, diaphragm process with lead anodes and palladosammine chloride with ammonia and ammonium chloride as electrolyte is used

Rhodium plating. Rhodium plating is done from baths containing either rhodium sulphate or rhodium phosphate. Rhodium sulphate bath gives a more lustrous plating As the metal is very costly, it is generally plated over nickel or silver base and the thickness of rhodium plating of the order of hundred thousandths of an inch imparts complete inertness towards acids.

Indium plating: Indium is plated from indium cyanide bath containing indium chloride, sodium cyanide and dextrose. It is also plated from indium sulphate containing sodium sulphate.

Alloy Plating: Alloy formation can take place under electric stress at the time of plating from baths containing metal ions which are constituents of alloy or by thermal diffusion after separate electrodeposition of the constituent metals. When an alloy is deposited from a bath, the four factors pH, temperature, voltage and current density are the most important factors. The proportions of salts of the constituent metals in the bath are important, but these are not very essential for the formation of alloy. Thus with a smaller percentage of one salt in the bath, it is possible to deposit alloy containing higher percentage of the metal constituent of that salt. The alloy anodes are generally used but it is also not an essential requirement

Brass It is possible to deposit copper zinc alloys of different composition, *viz*, gild metal (90:10), cartridge brass (70 30), muntz metal (60·40) The electrolyte contains copper cyanide, zinc cyanide, sodium cyanide, sodium carbonate In order to maintain uniform colour, ammonia is sometimes added in small quantities If the factors for the production of the required alloy are not held under reasonable control, variations in composition of the alloys will take place or in the extreme either copper or zinc may alone be deposited

Bronze The bath contains sodium stannate, copper cyanide and sodium hydroxide. In addition to the control of composition and temperature of 60°C, vigorous agitation of the bath and continuous filtration are necessary Since, the anode dissolves as stannate at a higher voltage than copper, the anodes are arranged separately on the two sides of the cathode, the voltage for the tin anode side being higher than that of the copper anode side. Various compositions are possible, including speculum alloy deposition

Tin Zinc Alloy· From a bath containing sodium stannate, zinc cyanide, sodium cyanide and sodium hydroxide an alloy of 78 per cent tin and 22 per cent zinc can be deposited at about 70°C It gives a high corrosion resistance to steel

Copper lead alloy: The solubility of lead in copper is very low when the metals are melted together When electrodeposited, however, solid solution or compound formation, according to constitution diagrams, obtained through thermal method of formation does not appear Copper lead alloys, with 18 to 25 per cent lead, can be produced by electro-deposition and are used for high performance friction bearing. Their compression strength is of a very high order. The plating bath contains copper hydroxide, potassium tartrate, lead acetate, potassium citrate and potassium hydroxide. Vigorous agitation of the bath during plating is essential, otherwise striated deposit of lead and copper will appear

Lead tin alloy: Lead tin alloys can be obtained from a bath containing lead fluoborate and tin fluoborate. Fluoborate baths are generally highly efficient from the point of view of rate of deposition, throwing power and current efficiency. Terne coating, solder coating can be produced from this bath.

Nickel cobalt alloy Various percentages of nickel cobalt alloys can be deposited from the bath containing nickel sulphate, cobalt sulphate, nickel chloride and boric acid. These alloys are bright in appearance and production of these alloys forms a method of bright nickel plating

Gold alloys When silver cyanide is added to gold plating bath, the rich yellow colour of gold combines with the white colour of the silver to produce a greenish colour. Similarly, addition of copper cyanide will give rich guinea gold colour, addition of nickel white colour and addition of zinc lavender colour.

Iron nickel alloys: From a bath containing nickel ammonium sulphate, iron ammonium sulphate, nickel or iron chloride and boric acid, alloys of iron and nickel having various compositions can be produced ; such alloys will contain pure iron and nickel only and as a result are important for corrosion resistant properties, magnetic properties and for glass-to-metal sealing purposes

Thermal diffusion of metals at a temperature much lower than fusion temperatures after electro deposition is also used extensively Thus the alloy of silver and lead which can not be produced by fusion owing to insolubility of lead in silver is obtained by electro deposition and thermal diffusion at 370°C The alloy of silver, lead and indium is known to have the highest compressive strength among bearing alloys and is used in Rolls Royce Merlin Engine bearings Silver Cadium is also of interest as a bearing metal The casting method of production of lead antimony tin bearing alloys often gives trouble due to segregation Application of electrodeposition and thermal diffusion can completely overcome such difficulties

Practically it is possible to produce binary and ternery alloys of different metals having a variety of compositions by electrodeposition or by combination of electrodeposition and thermal diffusion The characteristics of such alloys will be of great importance to engineers and will help in the production of better design of machines and stores

MEDICINE AND PUBLIC HEALTH

ANTIBACTERIAL ACTION OF POLYPORIN*

The success of the penicillin programme suggested Prof S R Bose (Carmichael Medical College, Calcutta), a search for antibiotics among the *Polypores*, a group of higher fungi with the study of which Prof. Bose is now connected for more than a quarter of a century Since May 1944, Prof. Bose has taken up a study of the antibacterial activity of the culture-filtrate of *Polystictus sanguineus* (collected from decomposed wood, logs and bamboos from India and not reported so far from Europe), and the filtrate is designated as 'polyporin' (See SCIENCE AND CULTURE, October, 1945, p. 191)

The details of the experiments conducted on the culture of the fungus and collection of the antibacterial substance ; on the assay of polyporin in the laboratory ; on antibacterial action ; on toxicity tests and animal experiments , on antibacterial titre in wood-destroying fungi ; on chemical investigation and on concentration are detailed in the *Bulletin of the Botanical Society of Bengal*, April, 1947, pp 71-80

From the results of these experiments it has been found that the active substance is thermostabile and nonvolatile, but it is destroyed on prolonged heating with steam at 100°C in presence of alkali and acid. It is acidic in nature and fairly soluble in dry ether The substance has not yet been obtained in a crystalline form Further investigation to isolate the antibiotic in a purer form from the ether extract of the purified and concentrated culture fluid is in progress.

In the absence of polyporin of the highest purity, it is not yet possible to state exactly the part polyporin is destined to play in treatment of infectious diseases But clinical trials with crude polyporin in Calcutta hospitals during 1944-46, are sufficiently encouraging to justify trials on larger varieties of cases or at least in cases where other methods have failed to produce any effective results. Polyporin has so far been found to produce no toxic effect

Polyporin is susceptible to a wide list of organisms tested so far *Staphylococcus aureues, Streptococcus pyogenes, S viridans, B. typhosus, B. para typhosus A, B para typhosus B, B coli, V. choleroe,* and *B. flexner.*

* Summary of the Presidential address by Prof. S. R. Bose, at the Eleventh Annual General Meeting of the Botanical Society of Bengal held on 26-4-47 at Calcutta

Striking results have been obtained with the following varieties of cases by local application of polyporin (1) abscesses and boils; (2) carbuncles, (3) bed-sores; (4) eye infections, (5) ear, nose and throat infections, (6) different kinds of ulcers and (7) infected lymph glands

Clinically polyporin has been tried orally in cholera cases in Carmichael Medical College Hospitals and the results are satisfactory One ampoule of polyporin containing 3 c c of the crude filtrate, is administered orally every four hours A larger number of trials have yet to be made to establish its efficacy

Fifty four cases of typhoid and paratyphoids have been treated in the same hospital and on some private cases of local medical practitioners with polyporin, among which 3 deaths are reported Polyporin controls the temperature within a very short time and it lessens the toxicity and prevents complications like tympanitis, diarrhoea, haemorrhage etc It further cuts short the period, if the administration is commenced early

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METHOXONE AS ERADICATOR OF WATER-HYACINTH AND OTHER AQUATIC WEEDS

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FROM the primitive age, when man perhaps first learnt the art of cultivating crops of his own choice, it has always been the endeavour of man to eliminate or check the growth of those plants which are not liked by him or are economically useless In general, plants which were not wanted or were growing in wrong places may be denoted as weeds. It may be woody or herbaceous plants In the present development of the different aspects of plant science, weeds have come to the forefront, because weeds compete with the cultivated crops in occupying space, reducing soil nutrients and deteriorating soil fertility, they further harbour diseases or insect pests which attack the economic crops Most virus diseases are spread by insects and in every known case weeds serve as hosts for the insect vector; they also may harbour the virus pathogen Many bacterial or fungus organisms causing diseases of plants, or insects, are harboured by weeds. The eradication of weeds, therefore, has assumed great importance in the present day cultivation of farm-crops In India, no systematic study on the weed problems has been made nor has any attempt been made to estimate the huge loss which the farm crops sustain due to the growth of weeds In the U. S A., regular organizations for weed control have been formed and this aspect of the problem has received well deserved attention

Chemical herbicides.—The most popular and easy method used by farmers to remove the weeds is to plough and replough the fields and thus remove them by mechanical means. But along with the gradual increase in the use of chemical substances in relation to cultivation and plant growth, many chemical substances have also been used as herbicides or poisons for killing weeds or removing them.

According to Hildebrand[1], herbicides in many forms are used as (*a*) soil sterilants, such as sodium arsenite, ammonium thiocyanate, borax or borate ores, carbon bisulphide, chloropicrin, or sodium chloride, (*b*) selective sprays as different acids like

FIG 1 Normal water hyacinth plants growing in an earthen tub as control

H_2SO_4, oils and sinox (Sodium-di-nitro-ortho-cresylate) which wilt down most broad leaf weeds but leave grains, flax and grass virtually unaffected; (*c*) non-selective sprays such as numerous non-selective oils, acids and salt derivatives which kill all vegetation; (*d*) translocated poisons illustrated by arsenic trioxide, arsenic trichloride, sodium chlorate,

ammonium sulfamate ; (e) flame throwers illustrated by Sizz weeder, a machine designed especially for weeding row crops ; (f) miscellaneous devices, e g , for removing or crushing the water hyacinth, soil covers or barriers to suffocate weed growth

Selective poisons—Very recently (1942-44) substances have been found which are specifically poisonous to certain kinds of weeds without harming the cereal crops growing along with them. In 1934, Kögl, Haagen Smith and Erxleben (Slade)[2] found in urine a plant growth substance similar to auxin They named it Heteroauxin and identified it as β-indolyl-acetic acid Related substance as α-naphthyl-acetic-acid was found to possess similar biological properties Since then a large number of physiologically active substances have been found, which have been called plant growth regulators or 'Plant hormones'. In growth hormone studies, majority of the contributions have been made by American workers and especially by those in the Boyce Thompson Institute of Plant Research

FIG. 2. Effect of Methoxone solution (0 01%) sprayed over the vegetative parts after 24 hrs. and showing epinasty

Credit for the sensational discovery that certain growth regulating substances or plant hormones can also be used as herbicides belong to Zimmermann and Hitchcock.[3,4,5,6] It is interesting to note how the investigations of the effect of plant hormones on different organs of the plant led to the present day knowledge of the role of plant hormones as herbicides. The physiologically active substances can be divided into two groups, according to their specific effects, (Zimmermann[5])—(1) those which cause cell-elongation and initiate adventitous roots such as phenyl, indole, naphthalene, anthracene and fluorine compounds ; (2) those which modify the pattern of leaves and other organs such as active substances of naphthoxy, halogen substituted phenoxy and mandelic acids and nitro substituted benzoic acid compounds It is from studies of the second group of substances that our knowledge of their herbicidal effects has been obtained. The first substance observed to possess the morphogenetic effects was B-naphthoxyacetic acid (Zimmerman and Hitchcock[5]). Later β-naphthoxypropionic acid, β-naphthoxybutyric acid and β-naphthoxyvaleric acid were found to induce similar effects, when these were made up as water solution or emulsion and sprayed on the growing tip of tomato plants and other test objects ; all organs that grew after the treatment were modified. The new leaves varied from the normal, in size pattern, number of leaflets and venation The high degree activity of the second group of substances is also seen in the formative effect of these compounds in modifying the development of shoots, including stems, leaves, flowers as well as fruits which distinguish these substances from other well known growth regulators Of special interest and importance is the substitution of halogen, methyl and nitrogroups in the nucleus of phenoxy and benzoic acids as mentioned above

Phenoxyacetic acid as such is practically inactive but halogen substituted phenoxy compounds are activated, according to the position of, and the number of, substituted groups in the nucleus of the molecule For example, O-chlorophenoxyacetic acid is slightly active The substitution of the chloro-group in the para-position increases the activity ten to twenty fold However, a substitution of the chloro groups in both the ortho and para positions increases the activity still further Methyl groups substituted in the 3, 5 positions were inactive for cell elongation but induced modifications showing a formative influence on the plants The most active substituted phenoxy compounds for cell elongation are the 2, 4, dichlorophenoxyacetic acid (2-4-D) and the 2, 4, 5 trichlorophenoxyacetic acid (2-4-5-T). It is possible that with other combinations still greater activity could be obtained with substituted phenoxy compounds The substituted phenoxy compounds were found, therefore both active in inducing cell elongation as well as morphogenetic changes. The acids, methyl and ethyl esters, salts and amides of chlorophenoxy compounds were of approximately the same activity in (1) cell elongation involving epinasty and bending of stems and leaves ; (2) proliferation, internal cell elongation was followed by increased cell division and finally proliferations with many adventitious roots ; (3) inhibition of auxiliary buds.

These actions of 2,4-dichlorophenoxyacetic acid is highly-selective and its action is found to vary in different plants. According to their sensitivity to the 2-4-D compound the plants can be classified from

highly sensitive to relatively insensitive ones Generally it has been found that the broad leaved dicots are sensitive while large leaved monocots of which typical are the grasses, are insensitive In America a large amount of work has been done on different weeds to test the efficacy of plant growth regulators especially 2-4-D as selective herbicides,

FIG 3 Effect of Methoxone (0 01%) seen after a week from the time of spraying and showing discolouration and shrivelling of leaves

(Overbeck and Vélèz[7], Hildebrand[8]; Smith, Hammer and Carlson[9], Hammer, Moulton and Tukey[10]) In England Slade and Templeman controlled the growth of charlock in corn crops by applying α-napthyl acetic acid. It was found to be extremely effective in killing charlock but had little or no effect on oat and barley Templeman found several substances in a range of compounds prepared by Sexton to be far more toxic to weeds than α-naphthyl-acetic acid and were still harmless to cereal crops at conc. which killed the weeds. One of these compounds 2-methyl 4-chlorophenoxyacetic acid has been developed as a commercial weed killer under the name "methoxone"

On the initiation of the Imperial Chemical Industries, we have undertaken to test the efficacy of Methoxone as an eradicator of waterhyacinth and other aquatic weeds. It is interesting to recall that in 1921 the Government of Bengal appointed a commission under the Chairmanship of Sir J C. Bose[11] to enquire into the subject of the spread of waterhyacinth which had already become an acute economic danger. Certain preliminary investigations were carried out in the Bose Institute on the efficacy of the methods employed in different countries to check the spread of the pest. A short account of the investigation was published in the *Transaction of the Bose Research Institute* (Vol. III & IV, 1923, p. 785). It was found that (*i*) steam kills the portion of the plant above the water ; the submerged portions remain alive and thus bring about a rapid propagation , (*ii*) poisonous solutions applied to the root are carried upwards with the ascent of sap and thus kills the plant throughout its whole length ; (*iii*) application of poisonous solutions by means of spray causes only local death of the upper portion of the plant The poison is not carried downwards. The spraying is, therefore, ineffective in the destruction of the plant

Similar results on the effect of $CuSo_4$ solutions as poison sprayed over the vegetative parts were obtained by Parija and Kar[12], working on the physiology and problem of eradication of water-hyacinth at Cuttack, Orissa

EFFECT OF METHOXONE ON WATERHYACINTH (*Eichhornia crassipes*)

The present communication contains a preliminary account of the results so far obtained by us with Methoxone We are indebted to the Imperial Chemical Industries (India) Ltd for supplying us free of cost both solution and powder containing Methoxone.

EXPERIMENT WITH METHOXONE DUST 1%

Experiment 1 —Full grown waterhyacinth plants were taken out from tank and allowed to grow in large earthenware tubs for two to three days. After they had thoroughly established themselves in the tubs, different experiments were conducted on them. The tubs were kept in a glass house, so that the experiments were not disturbed by rain or bad weather. The Methoxone dust was sprayed uniformly on the upper vegetative parts of the waterhyacinth population The vegetative parts which remained submerged naturally did not come in contact with the sprayed dust The plants were observed daily. After 24 hrs the leaves showed epinastic bending, *i e* , the distal end of the petiole above the bulbous portion showed fine curvature due to the differential elongation of the cells in that region. Epinasty is the first visible indication of the sensitiveness of the plant to Methoxone The lamina of the leaves were then found gradually to shrivel and become flaccid. This continued till all the leaves became dried up and etiolated and the plants ultimately died. The dead plants did not survive again but rotted in the water The plants were thus killed and totally disintegrated after about 15—18 days from the day of spraying with Methoxone.

Experiment 2.—The dust was made into a paste with white vaseline. The concentration of the dust was 50 to 50 in relation to the weight of the vaseline used. The paste was applied on different parts of

the waterhyacinth plants for instance on the dorsal and ventral sides of the lamina, round the bulbous petiole and on the just unfolding youngest leaf It was found in general that when applied on localized parts the induced effect was observed in other parts of the plants as well. Localized application on the youngest leaf brought about an immediate epinasty in the second younger leaf, which effect gradually travelled to the other leaves, but the older leaves were less affected or in many cases not affected at all. Both ventral or dorsal application on the lamina of the leaves induced the same effect, and no differentiation was noted The same was the effect of application on the bulbous petiole only It was, therefore, concluded that localized application on the active growing regions of the plant, brought about a gradual induced effect on the other parts of the plant as well But the general application on all the parts hastened the effect which quickened the early degeneration of the plant organism

FIG. 4 Showing total disorganization and death of the plants when the roots separated from the vegetative parts after 17-20 days from the time of spraying with 0.01% Methoxone

Conclusion.—The above two experiments showed that spraying of Methoxone dust on the vegetative parts of waterhyacinth was very effective and ultimately killed the organism Localized application on the organs of the plant brought about an equal effect on the other parts of the plant though the effect was slow. Dusting of the young leaves on the growing point was found to be very effective. The dust which contained 1 per cent Methoxone when sprayed once on the vegetative parts above water, was sufficient to kill and disorganize the organism within a period of 20 days

EXPERIMENTS WITH METHOXONE SOLUTION

Experiment 1.—Experiments were conducted in large tubs with 20 well grown healthy plants in each tub. The controls were kept similarly in separate tubs First the stock solution of 10 per cent was used. The solution was sprayed by means of a sprayer on the vegetative portion of the plants. It was observed that epinasty of the leaves set in after 6 hrs Marked epinastic curvature was found after 24 hrs with tips of the lamina showing signs of shrivelling After 48 hrs the leaves showed brown patches and etiolation On the 4th day the leaves all became brown and dried up, the whole plant looked flaccid and dying. Later the plants began to rot in water and while pulling out of water the dried leaves separated from the stem leaving the roots in water Such disorganized plants and plant parts never revived again. Thus all the plants were completely destroyed within 8—12 days from the time of spraying.

Experiment 2.—To find out the minimum dilution which may be lethal to the plants the following dilutions of the stock solution were tried :—

Dilutions	Approximate time taken for setting of epinasty in the leaves	Approximate time taken for showing discoloration and shrivelling of leaves	Total disintegration and death of the whole plant
1 0.1%	After 12 hrs marked epinasty all the leaves affected	48 hrs	12—15 days
2 0.05%	Ditto	48 hrs	12—15 ,,
3 0.025%	After 12 hrs but the old leaves not affected	4 days	15—17 ,,
4 0.012%	After 12 hrs old leaves not affected	6 days	17—20 ,,
5 0.01%	Ditto	6 days	17—20 ,,
6 0.001%	After 12 hrs only the youngest leaves showed epinasty	No effect	No effect
7 0.0001%	After 24 hrs only the youngest leaf of the growing shoot.	No effect	No effect

From the above results it was clear that the waterhyacinth plant was sensitive even at great dilutions of Methoxone as far as the epinastic response was concerned But the effective killing quality of the different dilutions markedly differ from each other. The killing efficiency of a dilution can be measured by the rapidity and the degree of epinasty brought about after 12 hrs and the extent of the effect produced. For example in 0·1 per cent dilution the strong epinastic effect was brought about after 12 hrs and all the leaves beginning from the youngest to the oldest of the plants were affected and consequently the plant died and disintegrated within 15 days. While in 0·01 per cent the epinastic effect was shown after 12 hrs. but was confined to the

three topmost young growing leaves of the growing shoot. At this concentration, the plants died and disintegrated within 20 days In still lower dilutions plants showed epinastic curvature and the leaves showed morphogenetic changes, *i.e.*, the leaves became small and stunted and crumpled in various patterns, the bulbs became short and more rounded. The vegetative shoot proliferated into many young stunted leaves But the plants were not killed nor disorganized but they try to return to the original condition again Hildebrand[8] investigated the herbicidal effect of 2-4-D on waterhyacinth and found that conc. 1 : 1140, 1 : 1700 and 1 : 1000 were effective in killing waterhyacinth by the end of two weeks One week after application, the upper parts were epinastic and discoloured

Experiment 3.—The experiments tabulated above were all conducted with single spray on the plants and the effect noted Further experiments were conducted where lower dilutions were sprayed more than once It was found that 0·01 per cent is the minimum dilution where the plants were more or less killed at about 20 days with one spray In lower dilutions even with spraying four times after each 3 days the plants were not entirely killed, though they became flaccid and etiolated.

Experiment 4.—When the spraying was confined to certain localized parts of the plant, such as the lamina of the leaves, the effect was carried to other regions of the plant and the growing shoot was affected The youngest leaves were more affected than the older ones The effect was inferred from the epinastic curvature of the different parts

Experiment 5. Time of spraying.—It was found that spraying with 0·01 per cent solution in the morning and in the evening showed different results The morning spray did not bring about the same degree of epinasty as the evening spray, as noted from observations made after the lapse of an equal interval from the time of spraying This indicated that an intervening dark period was more favourable for the Methoxone to act on the plant organism than a light period This may also be possibly connected with the higher temperature prevalent during the day. This was further confirmed by another experiment, in which the sprayed plants were kept in the dark for 24 hours in the first instance, and then kept under the normal conditions of the day and night The dark treated plants showed stronger epinastic movement than the controls and also were disorganized and killed some 4 days earlier than the control.

Experiment 6: Effect of different solutions.—Waterhyacinth plants were allowed to grow in different solutions of 2·0 per cent, 1·0 per cent, 0·5 per cent, 0·1 per cent and 0·01 per cent dilutions. The vegetative parts were kept out of contact with the solution It was found that the effect was much slower than the spraying with the same dilutions. The leaves showed delayed epinastic curvature which was also not so marked as was the case in the spray experiments The plants became flaccid, then brown and etiolated only in 2·0 per cent and in 0·1 per cent dilutions and the plants died after 20 days. But in other dilutions as in 0·5 per cent, 0·1 per cent and 0·01 per cent some effect was shown but the plants were not killed. This experiment showed that the spray method was far more effective than the solution method

FIG 5 Showing a typical epinasty and morphogenetic changes of the vegetative shoot as a result of Methoxone spray

Experiment 7 Effect of Methoxone on other weeds as Lemna, Pistia and Salvinia.—All the experiments described above with waterhyacinth were repeated with the other weeds—*Lemna*, *Pistia* and *Salvinia* It was found that 0·1 per cent dilution of Methoxone acted as lethal on these weeds when sprayed on their leaves But the same dilution when applied as culture solution was not so effective In Pistia where we have erect rosette of leaves, the effect was noticed by drooping down of the leaves and crumpling of their edges Later brown and etiolated patches appeared on the leaves with ultimate disorganization of the chlorophyll content and the dying leaves looked transparent while floating on the surface of the water.

Conclusion.—The preliminary investigations clearly showed the efficacy of Methoxone as a means of eradication of waterhyacinth. Its action on waterhyacinth is specific and a wide range of dilutions can well be effective. Dilutions of the order of 0·01 per cent when sprayed once on the vegetative parts of the waterhyacinth plant has proved to be quite effective in gradually disorganizing and killing the plant

organism within a period of 20 days Higher dilutions 1 in 10,000 was effective in producing morphogenetic changes but the plants were not killed The mode of action of Methoxone on waterhyacinth appears to be of a different nature to that of solu-

FIG 6 Showing a closer view of epinasty of the leaves

tions of inorganic poisons. The latter one was effective in killing the whole plant only when introduced through the roots, the former is far more effective when sprayed on the leaves, the first region to be affected is the growing point of the plant. Like other plant auxins its action appears to be primarily on cellular metabolism, at higher concentration it perhaps also inhibits cell-proliferation and cell activity probably through the inactivation of some cell-enzymes Van Overbeek and Vélez[7] have found that 2-4-D destroys the growing point and the intercalary growth regions in *Commelina* and in *Cyperus* the well protected growth regions located within the base of the leaf sheaths and 5 cm. or more below the leaf surface is decayed Methoxone has similar properties of preferential action on the growing region of waterhyacinth Methoxone spraying, therefore, is a promising method for large scale eradication of the waterhyacinth pest, field trials on a larger scale will show whether it is also economically feasible.*

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* I am thankful to Prof D M Bose, Director, Bose Institute, for his keen interest in the work and for many valuable suggestions and to the management of the Calcutta Branch of the Imperial Chemical Industries (India) Ltd for kindly supplying free samples of Methoxone I am also thankful to Mr Kanti Choudhury for taking the photographs

BOOK REVIEWS

Scientific Workers and Their Rights—Published by the Association of Scientific Workers (India), 210, Bowbazar Street, Calcutta. Pp. iii+48. Price As. -/12/-

The book was originally published in Great Britain specifically written for the scientific workers there Nevertheless, there are important chapters which would be of great help to scientific workers in India as well. That is why the A Sc.W (I) have thought it worthwhile to reprint the booklet with certain relevant alterations making it uptodate.

That those who work in the domain of science should engage themselves only in the pursuit of "selfless scientific work" is an idea of bygone days Scientific and non-manual work in laboratories and factories in academic and non-academic institutions are today nothing but different forms of trade And people engaged in trades and professions have a right to demand for security of their employment This becomes incumbent in face of the army of scientific workers employed in industrial concerns creating conditions of hard competition which is at times unnecessary and injurious to the interests of scientific profession. Thus, "to improve the economic conditions of scientific workers" has been one of the fundamental responsibilities of the Association in Great Britain

But the members of the Association have other duties as well. They consider it their responsibility to see that scientific knowledge is made accessible to all citizens and that industry takes full advantage of scientific achievements Only thus can production be kept high, inflation checked and buying power of the people be kept at par to ward off the evils of unemployment

The booklet, which was meant to serve the purpose of a Course of Study for those who are interested in trade unionism among scientific workers, was prepared by J. Kuczynsky in collaboration with others As an economist and statistician the writer is well known all over the world. His grasp of essentials and treatment of the problems of such vast nature in a small space is an evidence of his mastery of the subject.

In a foreword to the Indian Edition, written by Prof. M. N. Saha, it has been aptly pointed out that, "It will not do to depend upon persons with saintly haloes or demagogues who thrive on cheap slogans to rouse wrong passions in the uneducated mass mind, which become dangerous slogans; the scientific workers themselves will have to provide leaders, who would come to the top on the basis of their knowledge and experience of work, and utilize this knowledge for taking part in steering the machinery of the State towards the right end."

Snow Balls of Garhwal—Folk Culture Series—Edited by Dr D. N Majumdar, The Universal Publishers Ltd, Lucknow, 1946. Pp. 87+5. Price Rs. 3/12/-

The publication is divided into two parts In the first part there are three articles and a collection of songs by W. G. Archer. These are translations of songs published earlier in Santali The article on folk songs of Dangi Bhils by D P Khanapurkar contains a useful collections of songs of this tribe. The note by Sir Sitaram on Indian folklore has presumably found its place in the collection as he is the President of the newly formed Ethnographic and Folk Culture Society, Lucknow. Dr D N. Majumdar who is the Secretary of the Society besides being the editor of the collection, contributes an article entitled "The Malaise of Culture". He enumerates the evils that have crept into tribal society as a result of contact with "European or Quasi-European cultures" which in his view have led to "discomforts among the tribal people even to depopulation in their ranks" At the end of the article, the writer laments the lack of contribution of Indian writers on this subject The writer has missed two important points. The economic difficulties under which tribes live should be studied on factual basis and attention directed towards solving this problem Such studies can be carried out only with adequate State help or endowment of Universities Under foreign rule in this country, this has not been encouraged except among European officials for administrative purposes Also, the results of such surveys have been utilised mainly for administrative ends and not for solving the problems of tribes We miss any reference to Rai Bahadur Sarat Roy whose contributions in this field are valuable, and who had earlier discussed practically the same problems in Chota Nagpur

The second part of the publication contains a fairly large collection of folk songs of Garhwal from which the title of the book is derived. Mr N. S. Bhandari states that he has collected about 200 songs in the interior of Garhwal and the 60 he has printed in this work are a selection from this collection which will shortly appear in print. Folklorists will await this with interest.

There are some fine Lino cuts by Mr L. M. Sen, Principal of the Government School of Arts and

Crafts, Lucknow The absence of any caption or note regarding them however renders their value uncertain beyond adding "colour to the volume".

There is also an appendix in which the rules and regulations of the Ethnographic and Folk Culture Society are described. We hope it will flourish and do useful work. There is plenty of room for such societies in India.

K. P. C.

Malay Fishermen : Their Peasant Economy—By Raymond Firth. P 354, fig 27, plates, 31, map 2 Published by Kegan Paul, Trench and Trubner & Co , Ltd., London. Price 25 Shillings.

Prof. Raymond Firth displays originality in the weaving of the plot and cleverness in characterisation. Prof Firth wields a facile pen and knows the technique of handling his theme in an ingenious way. The book breathes the atmosphere of the fishing industry in Malay and Indonesia including the planning and organisation of fishing activities, marketing organisation, system of distributing earnings, output and levels of income, fishermen's position in the peasant economy and lastly development of fisheries.

'Malay-Indonesian fishing is by no means a purely subsistence occupation—The claims of the peasant fishermen must also be borne in mind They too, are an important part of economy Their importance lies not only in their actual population—which is considerable although but a fraction of the whole Malay and Indonesian peoples—but also in their contribution to the economic and nutritional system of the community Fish, sometimes fresh but more often dried or likewise cured, is the normal accompaniment to rice in the peasant meal in most Far Eastern countries' 'Fish is an important item of food of Bengal next to rice' says the reviewer in an article 'The problem of fish, fishing and fishermen in Bengal', published in *Calcutta Review*, April, 1945 Bengal fishing is also a main occupation among the fishermen castes (Jalia, Paroi or Rajbanshi) of Bengal. In Bengal fresh fish is usual but dried fish is not an uncommon one. The importance of food value of fish is also a great one among the peoples of Bengal.

Prof. Firth mentions that 'The variety of fish that can be taken in these waters is very large'. Late Mr K. G. Gupta in his reports has stated that in Bengal the largest depository of varieties of fish can be found in the eastern and western parts of Jessore and Faridpur respectively and the adjoining parts of Khulna.

'The kinds of equipment and technique used in fishing in these regions are bewildering in their variety'. In Bengal specially the fishermen use various types of nets, traps, spears, harpoons, listers, hooks, gorges, rods and lines etc

'One is tempted to think of these oriental fishing communities as possessing and requiring little capital and having their labour as their main investment This would be a misconception'. But in Bengal this is partly true. In Bengal individual fishing is the usual practice but in Malay co-operative system runs.

'The economics of this fishing industry, despite its importance, had received little detailed study before the war. The officials of the Fisheries Department, Strait Settlements and Federated Malay States made brief periodical investigations but they had small time for economic analysis'. In Bengal the Department of Fisheries, a newly created department—is now engaged mainly for the production of fish The economic condition has not yet been taken into consideration The Department of Anthropology, Calcutta University has surveyed some sample villages. This is really a microcosm of Bengal fishing

In chapter XI (*i e* last chapter) Prof Firth delineates the basic problems, technical development, economic development and social change due to development of fisheries in Malay In appendix I, he has shown the advantages and disadvantages of the anthropological methods, specially the value of direct observation, testing assumption, conditions of work etc.

A science which can correlate other sciences is a real practical Science The volume, the reviewer thinks, is meant for the geographers, zoologists, agriculturists, sociologists, economists and anthropologists as it offers a variety of information on variety of topic, though the pen has come from the hands of a Professor of anthropology.

Fish shortage has become an acute problem in Bengal Economic adjustment with fish, fishing and fishermen is also an important factor for due consideration Pisciculture is one of the main industries of Bengal, which is being hurled into the abyss of destruction owing to the want of any proper knowledge of the thing. The Government of Bengal and the University of Calcutta should encourage enquiries on the line shown by Prof. Firth, by their scholars in future, to make Bengal industrially vigorating.

M. N. B.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

PRELIMINARY NOTE ON THE ACTION OF PENICILLIN ON *PASTEURELLA BOVISEPTICA*

PENICILLIN is effective primarily against gram-positive bacteria, the chief exceptions so far known being gonococcus and meningococcus. Pasteurella is generally believed to be non-susceptible, but at least one member of the group, appears to be susceptible *in vitro* to penicillin.

Pasteurella boviseptica, grown on blood agar for 24 hours, was suspended in sterile saline to match No 4 of the 'Welcome' brand opacity tubes Tenfold dilutions of this suspension were subsequently made in saline 0 1 c c. of each bacterial dilution was added to 4 9 c.c. of nutrient medium, the basal medium consisting of either plain broth or a mixture of 4 parts of 1 per cent glucose-broth and 1 part of bovine serum The sodium salt of penicillin containing 1620 units per mg. was diluted in normal saline under sterile precautions. Growth was measured by the appearance of turbidity after 24 hrs' incubation at 37°C. Survival of the penicillin-treated organism after 24 hrs'. incubation was tested by incubating a loopful of the incubated culture on blood agar for 48 hrs Two strains of *Past boviseptica*, HS(52) and HS(25), isolated at this Institute, were used, the former being virulent and the latter avirulent.

Organism	Dilution	Lowest concentration of penicillin completely arresting growth (unit/c.c)	Lowest concentration of penicillin partially arresting growth (unit/c c)	Survival of penicillin-treated organism after 24 hrs ' incubation
HS (52)	10^{-1}	0 5	0 1	2 or 3 colonies
	10^{-3}	0 5	0 1	No growth
	10^{-4}	0 5	0 1	"
HS (25)	10^{-1}	0 5	0·1	"
	10^{-3}	0 5	0 1	"
	10^{-5}	0 5	0 1	"

Experiments were also carried out to see the effect of penicillin on the respiration of this organism. The reagent however had no effect on the respiration of 'resting' *Past. boviseptica* (virulent strain) in the presence of glucose, aspartic acid or fumaric acid as substrates. Some earlier workers[1, 2] also obtained similar results with staphylococcus as test organism. Others[2, 3] found that penicillin added to growing cultures of *Staph. aureus* inhibited respiration of the organism

The respiration was measured by us by Warburg's technique, using organisms washed in phosphate buffer at p^{H} 7·4 and finally suspending the washed organism in the same buffer in Warburg vessels, the substrates being added from the side limbs after equilibration of temperature

Though no definite information is available as to the action of penicillin on this organism *in vivo*, it has been reported that penicillin was successfully used in the treatment of two cases of haemorrhagic septicaemia (pasteurellosis).[4]

The penicillin used in this experiment was given to us by Imperial Chemical Industries Ltd

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Mukteswar-Kumaun, 7-1-1947.

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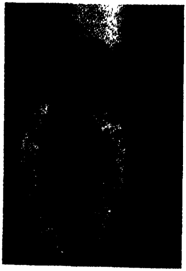
PENICILLIOPSIS CLAVARIAEFORMIS SOLMS LAUB.—A NEW RECORD IN INDIA

IN October, 1946, the writers discovered a Clavaria-like fungus growing inside the endospermic cavity of the dead stones of *Borassus flabellifer*, cut into half, in the village Kunipara, Tejgaon, Dacca. The fungus is gregarious in habit, several fruit bodies compacted together in a bunch and filling the whole cavity of the stone. The fruit bodies are pseudoparenchymatous, upto 40 mm. in height, erect or a little bent near the tip, unbranched when young and bi-or trifurcated at the tip later on, thicker in the middle and gradually tapering towards the base and the apex. The colour of the fruit bodies ranges from old gold when young to mummy brown when fully mature. The surface of the fruit bodies consist of conidiophores and conidia, which closely resemble in

shape those of a *Penicillium* Conidiophores are swollen at the tip, simple or sometimes branched, the tip of the branches being similarly swollen On the swollen tip of the conidiophores are placed a number of sterigmata in a whorl The sterigmata are cylindrical to fusiform, continuous or one septate, bearing at their tips prominently walled, ovoid,



A

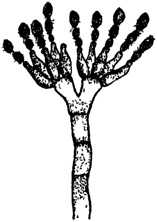
(A) The fungus in natural habitat

smooth, greenish yellow conidia in chains A chain of conidia is enclosed in a thin hyaline gelatinous sheath

B

(B) The clavaria-like stroma shown separately.

Specimens of the fungus were sent to Dr S P. Wiltshire, Director, Imperial Mycological Institute, Kew, England, and he writes:—"The specimens have been examined by Dr Bisby who reports as follows—From examination of the fungus on fruits of *Borassus* and comparison with specimens in Kew Herbarium, I agree that it is probably *Penicilliopsis clavariaeformis* Solms-Laub, which is generally found on fruits of *Diospyros*, but sometimes on other fruits . . . I have not seen a record of *Penicilliopsis clavariaeformis* Solms-Laub in India".



C

(C) Conidiophore with sterigmata and conidia

Ascigerous stage of the fungus has not been found.

Penicilliopsis clavariaeformis Solms-Laub in *Ann. Jard. bot Buitenzorg*, *6*, 53, 1887
Saccardo, *Syll fung*, *9*, 945, 1891, Hauman, *Bull Soc. Bot Belg*, *69*, 96-129, 1936

Stroma clavaria-like, simple, bifurcated or trifurcated at the tip, erect or bent towards the apex, thicker in the middle, tapering towards the base and apex, old gold when young to mummy brown when mature, 20-40 mm long. Hyphae 5 8—8 0 μ in diameter Conidiophores swollen at the tip, septate, simple or sometimes branched, with a whorl of aseptate or one septate, unbranched, cylindrical to fusi form sterigmata at the tip Conidia smooth, prominently walled, ovoid, greenish yellow, borne at the tips of sterigmata in chains. Each individual chain of conidia is enclosed separately within a thin, hyaline, gelatinous sheath.

On dead stones of *Borassus flabellifer*, Kunipara, Tejgaon, Dacca, 25-10-46. Specimens deposited in the Herbarium of the Imperial Mycological Institute, Kew, England.

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SYNTHETIC CASTOR OIL—A PRELIMINARY NOTE

Castor oil is an important article of commerce. Its use in medicine, as lubricant, in the production of boiled oil substitute, in the preparation of transparent soap and in the production of numerous synthetic perfumes through various decomposition reactions is well known It has been used as hair oil, in the production of Turkey Red oil and in the production of artificial leather As its production cannot cope with its consumption it is natural that its price is high The purpose of the work was to produce an oil simulating castor oil starting from a non-drying oil like ground-nut oil The foregoing uses of castor oil are due to the presence of hydroxy acid, recinoleic acid, present as glyceride and for this reason the acetyl value of castor oil is 140-150 Other non-drying oils like ground-nut oil in the refined state have no acetyl value and the characteristic acids present as glyceride in them are oleic in maximum proportions and linoleic and linolenic acid in smaller quantities. Our experiments were directed to introduce OH hydroxyl groups in the acid residue so as to produce hydroxy acid of recinoleic acid type It will be seen from the structure of oleic acid and recinoleic acid.

$$CH_3.(CH_2)_5\ CH_2.CH_2CH=CH(CH_2)_7\ COOH$$
Oleic acid

$$CH_3.(CH_2)_5-\underset{OH}{CH}-CH_2.CH=CH.(CH_2)_7\ COOH$$
recinoleic acid

that difference only exist in the presence of one OH group in 12th position

For the purpose of our experiment we passed air through oil at various temperature in presence of various catalyst always avoiding polymerisation and decomposition which happen in the production of blown oils, and we have been able to produce an oil, simulating castor oil, having an acetyl value 125. This indicate that there is substantial formation of hydroxy acid like recinoleic acid. We are trying to produce similar oils from other non-drying and semi-drying oils and detailed results of all of them are reserved for future communications. The best result with ground-nut oil we have found with nickel at 70° when used as catalyst. This particular sample although not freely soluble in alcohol at ordinary temperature like castor oil gives a clear solution in the solvent at 49°C. The other characteristics of the new hydroxylated oil from groundnut oil is given in the following table. For comparison, the corresponding values of castor oil are given side by side. Investigations of the new acids produced are also in progress.

Values	Hydroxylated groundnut oil	Castor oil
Sp gravity	0 9902	0 960-0 968
Viscosity	4310 seconds Redwood at 25°C	3162 seconds Redwood at 25°C.
Refractive Index (Butyro-refracto-meter)	62 at 40°C	78 at 20°C.
Iodine value	52	81-90
Sapn value	199	175-183
Acetyl value	125	145
Diene value	0	0
Molecular weight	1215	1050

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Calcutta, 1-3-1947

A NOTE ON THE ESTIMATION OF QUININE SULPHATE

During the war, when the supply of quinine salts from Java was completely cut off, the price of quinine sulphate in India rose to such a high extent that adulteration with foreign bodies to the extent of 0·5 per cent was thought considerable. Moreover, the injectable quinine salt should be extremely pure. We were thereby confronted with the difficult task of establishing a rapid routine method for analysis of quinine sulphate B.P.

The British pharmacopoeia specifies that quinine sulphate B.P should contain 73 5 to 76 5 per cent anhydrous alkaloid and it should lose on drying at 100°C not less than 11 per cent and not more than 16 per cent of the weight. From the limit of allowance in moisture in British Pharmacopoeia it seems that quinine sulphate B.P. should contain 5½ to 7½ molecules of water of crystallisation. It is known that quinine sulphate crystal effloresces rapidly and loses all except 2 molecules of water of crystallisation when exposed to air or when heated to 50°C. Calculating on this basis, the moisture content of quinine sulphate B.P. should not exceed 5 per cent when dried at 100°C.

But too long storage during the war, the samples of quinine sulphate B.P. were found to contain variable amount of water of crystallisation and the determination of moisture content accurately is extremely important. In order to find out a rapid method for our routine procedure, the moisture con-

tent was determined in two different ways In the first method the sample was dried at 80°C for ½ hour in an air oven It is then cooled in open air and weighed. In the second method, the sample was dried in a glycerine-water bath at 105°C for ½ hour. It is, then, cooled in a dessicator and weighed.

In the following table, some typical results obtained in our Laboratory are given :

Sample No.	% Anhydrous Quinine	% Anhydrous Quinine Sulph	% Moisture at 105°C	% Quinine Sulph Dihydrate	% Moisture at 80°C	Remarks
1.	66.0	75.4	12.0	79.4	8.5	Bad
2	73.8	85.0	12.5	89.1	8.2	Bad
3	76.0	87.5	12.0	91.7	8.2	Good
4	76.1	87.6	12.0	91.8	8.1	Good
5	73.0	84.0	13.0	88.0	10.2	Bad
6.	74.6	85.0	10.0	90.0	6.8	Bad
7	74.0	85.2	13.2	89.4	10.5	Good
8	76.0	87.5	11.5	91.7	8.2	Good
9	80.8	93.0	6.6	97.5	2.6	Good
10	79.0	90.9	9.0	95.3	4.7	Good
11.	82.4	94.9	5.0	99.5	0.4	Good
12	78.7	90.4	8.7	95.0	3.7	Bad
13	82.0	94.4	5.0	99.0	0.9	Good
14.	78.0	90.0	9.2	94.5	5.5	Good
15	79.8	91.8	8.0	96.3	3.5	Good

From the data in the table, it appears that

(*a*) a sample may contain anhydrous alkaloid and moisture within the limits of B.P. specifications but the sample may not be pure (*vide* sample Nos 2, 5, 12).

(*b*) a sample does not always lose whole of its moisture when dried at 105°C for ½ hour (*vide* sample Nos 7, 8, 14). Further drying is necessary.

(*c*) a sample loses all water of crystallisation except the two molecules of water when dried at 80°C for ½ hour. It was observed that the di-hydrate form of quinine sulphate is stable at 80°C at least for two hours. As such, no error due to over-drying is possible.

For rapid testing of purity of quinine sulphate, it is convenient to determine the moisture content by drying at 80°C for ½ hour. The quinine sulphate is to be expressed as dihydrate from the weight of the anhydrous alkaloid obtained after extraction with chloroform.

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"VEGETABLE GHEE" AS AN EDIBLE FAT

Dietary fat is the most concentrated form of our food that serves as a rich source of calories. Its additional importance lies in its use as a source and as a vehicle for the absorption of certain vitamins. Cow's or buffalow's ghee is the food fat of choice in India, but certain vegetable oils also are consumed as food fat For the short supply of the former as well as for an increased cost, a type of hardened fat, known as 'Vegetable Ghee', made by hydrogenation of the edible vegetable oils is assuming considerable importance as a 'Ghee' substitute. Considerable differences of opinion, however have arisen regarding the nutritive value of such hardened fat. The Government of India is considering this point from various angles.

In this connection it may be noted here that hydrogenated fat is being consumed in other countries for a number of years, as a substitute for butter fat In this country it is being mostly used for cooking and frying purpose. In any assay of its food value we should consider the importance from economic, social and nutritional aspects. A natural 'ghee' has a peculiar aroma owing to the presence of glycerides of lower fatty acids, contains some unsaturated acids and certain vitamins and is free from any injurious foreign substance. A vegetable ghee, on the contrary, may contain traces of metal derived from the catalyst used during hydrogenation, loses practically all its unsaturated acid components, contains no vitamin, and is being often made from oil which is not so used as an edible oil in the country. As such in finding out the nutritional value of a hydrogenated fat, the following conditions may be followed before ascertaining its role as a substitute for natural edible fat.

(*i*) The product should be made from readily assimilable edible oil ;

(*ii*) The hydrogenated fat should be free from any foreign and undesirable substances ;

(*iii*) It should not contain any appreciable quantity of glycerides of *iso*-oleic acid[1]

(*iv*) An appreciable percentage of unsaturated C_{20-22} acids glycerides[2] should be present so that we may get the above essential food constituent from the fat in about 1 per cent of our diet[3] ;

(*v*) Some aromatic substances may be incorporated to make it more palatable ;

(*vi*) Some carbohydrates may even be mixed with it in order to enrich it nutritive value[4] ;

(*vii*) The fat should be properly vitaminized to serve as a substitute for natural butter or ghee[5, 6] ; and

(*viii*) It should be finished in a way so that any oxidation and deterioration may be prevented.[7]

A vegetable edible oil which is being largely consumed in India, if properly hydrogenated, ad-

juvated and vitaminised, may serve as a substitute for an edible fat. Further as the presence of certain unsaturated acids like vaccenic, linoleic and arachidonic, acids is being considered to be of specifical significance for animal nutrition, it would be of much interest if the percentage of the above acids in our common edible oils, and even in human serum and tissues, be quantitatively determined and recorded.

U. P. BASU

Bengal Immunity Research Laboratory,
Calcutta, 14-3-1947.

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ABSORPTION SPECTRA OF LIQUID MIXTURES

THE absorption spectra of a mixture of two liquids is expected to give us the changes in spectra due to the replacement of the mutual molecular field of the absorbing molecules by that of foreign molecules With strongly polar foreign molecules, we expect that the absorption co-efficient at any wavelength should increase with the percentage of foreign molecules, as the greater field strength should facilitate transition to higher levels Investigations were undertaken to find out the nature of the observed changes in the absorption co-efficients

Previously, Pearce and Dawson[1] studied the effect of alkali and alkaline-earth solutions on cobalt chloride solutions. They have observed an increase in the width of the band which varies directly as the ionic charge and inversely as the ionic volume Effect of polar and non-polar solvents on I_2 and Br_2 have been studied by Walker,[2] Child and Walker,[3] Aickin, Bayliss and Rees.[4] In all these experiments extra thin films of the solutions were taken and measurements were made of the shift in positions of the absorption co-efficient maxima or the change in the shape of the absorption curve. It was observed by them that the polar solvents effected a shift of the absorption towards the ultraviolet. This is not according to expectations and no attempt has been made to explain the changes observed.

We have taken a mixture of CCl_4 and Alcohol in a column of absorbing liquid about 10 cms. long and it has been found by us that under circumstances the absorption becomes much more stronger than either of them alone. The effect is most marked when the CCl_4 molecules are in the field of a large number of alcohol molecules. The absorption coefficient increases as the percentage concentration of alcohol in the mixture is increased. The coefficients of absorption being calculated on the basis that CCl_4 are the absorbing centres. This is justified due to the fact that the CCl_4 molecules absorb much more strongly than the alcohol and also due to the fact that a very small percentage of CCl_4, of the order of ·001 per cent in a mixture with alcohol, gives a very marked change in the absorption spectra observed from that of either, whereas large percentage of CCl_4 brings the nature of absorption more and more alike that of CCl_4 The absorption due to Alcohol being on the further short wave side The curve obtained by plotting absorption coefficient against log concentration of CCl_4 gives an exponential curve, which has been verified by plotting a logα and log C-curve and getting a linear relationship between them. The absorption coefficient α may thus be represented by the relation.

$$\alpha = Ae^{-B \log C}$$

where α is the absorption coefficient, A and B are constants, C is the percentage concentration of CCl_4 in alcohol. Of the two constants, the constant B changes with the wavelength, whereas the constant A seems to be a characteristic of the material and independent of the wavelength. Further work on this line is being continued.

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N SUTRADHAR

Physics Department,
University of Dacca,
Dacca, 22-3-1947.

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TAPIOCCA AS A SOLUTION OF THE FOOD PROBLEM

THE general scarcity in basic food stuffs in large regions in India, the near-famine conditions that prevail in certain regions, and the memories of the tragic catastrophe that befell Bengal in 1943 have made people search for a solution of what is known as the "Food Problem". Reclamation of waste lands, and increased production from land already under cultivation have been repeatedly suggested as the means to remedy the deficit in our cereal supply.

Professor Afzal Hussain have put forward a practical plan of action which has at least the merit of being not a mere repetition of the obvious. Prof Hussain put forward his plan in his presidential address to the Indian Science Congress delivered at Bangalore in January 1946. "Instead of concentrating our efforts exclusively on the production of more rice and more wheat, change the food habits of the people Divert a part of the land now devoted to cereals, for the cultivation of tubers which yield more than ten times as much as cereals for any given area Don't worry over much about the low protein content of tubers. For if we grow an acre of Tapiocca (Cassava) we shall have as much carbohydrate food stuff as could be had from four acres under rice. Of the remaining three acres a portion may be used to grow crops with high protein content".

At present Tapiocca is grown chiefly in Travancore, Cochin and Malabar. At the suggestion of Prof P. C. Mahalanobis, F.R.S I brought some Tapiocca from Travancore to Bengal in 1945 and we have been growing it for three seasons now at the premises of the Indian Statistical Institute, Baranagore. In 1945-46 we had half a dozen plants some of which gave very promising yield. In the second season we had 27 plants which were planted in February 1946 and harvested in February 1947. Most of the plants were damaged by rats. The results of the experiment are given.

As at least 5000 plants can be planted in one acre, it is evident that even with our above rate of yield a total out-turn of 6700 lbs. can be expected per acre.

The experiment is being continued and any one interested can have a look at the plants at 87, B T. Road, Baranagore It is necessary to conduct these experiments on a large scale, and to do a good deal propaganda to popularize the crop It will be certainly worth while for the Agricultural Department to take up this matter

RESULTS OF TAPIOCCA EXPERIMENT AT BARANAGORE 1946-47

Serial Number	Height of plant in feet	Number of tubers		Weight of undamaged tubers in lbs.
		Undamaged	Damaged or destroyed by rats	
(1)	(2)	(3)	(4)	(5)
1	12	12	4	75
2	12	5	1	50
3	11	11	2	1 12
4	11	11	3	75
5	11	17	1	3 62
6	10	11	2	62
7	12	10	1	62
8	10	4	4	12
9	14	9	1	25
10	12	11	2	25
11	14	11	6	12
12	14	3	1	1 12
13	13	8	2	2 12
14	7	13	6	2 00
15	7	20	5	2 50
16	8	20	—	3 88
17	7	—	8	00
18	7	6	5	62
19	7	10	4	1 25
20	7	10	3	1 50
21	7	9	2	75
22	7	10	3	2 25
23	8	16	2	1 88
24	10	30	2	6 62
25	12	—	5	00
26	12	4	2	1 00
27	12	—		00
Average	10 15	10 04	2 93	1 34

N. T MATHEW

Indian Statistical Institute,
Presidency College, Calcutta
31-3-1947.

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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XII. JUNE, 1947 No. 12

THE CASE FOR SOYA BEAN

IN a 'conjecture' estimate of the overall position with regard to India's food production, the Health Survey and Development Committee, commonly known as the Bhore Committee, stated that in this country there was shortage of almost every type of food required for human nutrition—proteins, fats, carbohydrates, minerals and vitamins As regards cereals, the shortage was estimated to be operating in some 30 per cent of the families As regards milk, the intake per head per day was estimated to be possibly 5 ounces, as compared to 65 ounces in Canada, 55 ounces in New Zealand and 40 ounces in Great Britain The production of fish in a predominantly riverine province, with a large marine fishing ground, like Bengal is only 5 per cent of the estimated requirements. Meat and eggs are, of course, much more scarce and costly

In order to improve the quality of Indian diet, the Director of the Nutrition Research Laboratories at Coonoor suggests the inclusion of 8 ozs. of milk and 3 ozs of pulses to the daily diet of an average Indian adult containing 1 lb. of cereals, 6 ozs. of non-leafy vegetables, 2-4 ozs. of green-leafy vegetables, 2 ozs of fruits and 2 ozs of fats or oils. Expectant and nursing mothers and children up to 14 years have been assigned a larger supply of biological proteins. It is obvious that the deficiencies of food production and the low purchasing capacity of the people were two of the stumbling blocks which stood in the way of effecting an improvement

The production of more milk at a price within the purchasing capacity of the people, forms part of a long-range programme. Until such times as the stepping up of milk production would reach the required level, various suggestions have been made to meet the deficit of protein by exploring vegetable sources, like pulses, soya beans, groundnuts, gingelly and food yeast It was also known that India had only ¾ of an acre of land per head of the population and that four times as much land was required to produce one unit of food through milk and milk products as through cereals or pulses.

In soya bean, we have an easily cultivable crop, giving a large return per unit area and playing an important part in the rotation of crops. Besides being a useful fodder crop, it is of great industrial importance as a source of oil, raw materials for paints, plastics, adhesives, etc. From the view point of food it is accepted by a majority of scientific workers that it contains, weight for weight, more protein and fat in an assimilable form than do the common pulses in use in India It is rich in minerals and vitamins of the B group. The amino-acid composition of the soya bean reveals that it is a first-class protein, comparable to milk, fish, egg and meat. It was in this setting that this journal considered the potentialities of the soya bean in providing for a cheap but efficient source of biological protein until animal proteins could be adequately produced and equitably distributed to the Indian population (*vide* editorial, Vol. VII, January, 1942, Pp. 321-323). As unprocessed soya bean is not liked by some people owing to the presence of certain aromatic substances, we pleaded for the introduction of the processing industry in India. A number of articles bearing either on comparative studies or on the digestibility and assimilability of the soya bean protein have since been published in our journal. In an article published elsewhere in this issue, De, Subrahmanyan and their co-workers at the Indian Institute of Science, Bangalore, express the view that, when soya bean is processed according to their method, a remarkable improvement takes place in the quality of the soya milk. They claim that (1) it has a higher digestibility than cow's milk, (2) when

prepared from the bean after 3 days' germination, it has a higher biological value than cow's milk, and (3) when supplemented with calcium and some vitamins, it is in no way inferior to cow's milk. One should add that soya milk, soya curd and other products can be supplied at a fraction of the price of cow's milk. If the animal and human feeding experiments now being carried on, on a fairly extensive scale, at Bangalore substantiate the above claims by statistical evaluation, a step forward will be taken in solving widespread malnutrition in India

Some of the eastern nations have been accustomed to fortify their dietary for centuries by soya preparations, which, during the recent war, formed an important ingredient of the Army and the civilian rations In spite of these facts and favourable opinion of competent nutrition scientists in many parts of the world, the hesitant opinion of some workers of the Indian Research Fund Association with regard to soya bean, based on incomplete data, has done, we are constrained to say, a great harm to Indian nutrition and to Indian economy. It is admitted on all hands that "processing" of the beans is essential in rendering them more palatable and more digestible. It is a matter of great regret that most of the I.R F A. workers carried out their experiments with unprocessed whole beans, and that neither milk, nor curd, nor sauce or other preparations were included in their studies. As a result of feeding a small school group with *cooked* beans for only 20 weeks, Aykroyd and Krishnan (1937) came out with the opinion that soya bean did not constitute an important addition to dietary in India Later on, when public attention was drawn to its potentialities during the war and when other nations were supplementing their food resources with soya preparations, the Nutrition Committee of the I.R.F A undertook (1942-43) a comparative study of the nutritive values of soya bean *versus* Indian pulses The experiments (*vide* Report on Soya Bean by the Soya Bean Sub-Committee, I.R.F.A , January, 1946) are subject to the criticism that uniform methods of preparation (usually cooked or steamed whole beans were used in these experiments) and criteria of assessment were not employed by the selected workers, that the experimental samples were small and that the period of experimentation was too short.

The Committee came to the conclusion that the biological value of soya proteins was of the same order as that of the other pulses, although some of them (*e.g.*, K P. Basu *et al*) stated that soya bean was a more complete protein than pulse proteins. The Committee further expressed the following opinion :—

"Although soya bean contains more of fat, minerals, vitamins and 'available' proteins than other pulses, it has, *for some unknown reason, not proved itself superior to other pulses within the range of experiments reported here* (italics are ours). It is, however, possible that soya bean may, as has been pointed out elsewhere, prove a better supplement than other pulses to typical Indian diets which are quantitatively inadequate and based on cereals Further work on this aspect is desirable

"Taking the results so far into consideration, the Sub-Committee is of the opinion that as a supplement to typical Indian diets based on cereals, but supplied adequate in quantity, soya bean has no special advantage over common Indian pulses

"The Sub-Committee is not in a position, therefore, to advocate *immediately* the encouragement of the production of soya bean on a wide scale in India for use as a substitute for Indian pulses The question should, however, be reconsidered if and when further evidence on the nutritive value of soya bean becomes available."

With regard to the use of soya bean milk, the Sub-Cimmittee concedes that, suitably "fortified" by the addition of minerals and vitamins, it might be of value in the feeding of infants and children The Sub-Committee thought that, without further controlled trials at infant welfare centres and in schools, they were not in a position to advocate the general use of soya milk in India We are looking forward to the results of the experiments now being carried out by the Bangalore workers

The vacillating opinion of the I R.F.A Sub-Committee without proceeding to conduct further experiments with processed beans, including methods of improvement of processing technique, can only be confirmed or disproved by further work in these directions To this extent, the I R.F.A. Sub-Cimmittee has failed in their duty by losing sight of the object and failing to sponsor well-planned work When the opinion of Indian scientists regarding the value of the soya bean as a supplement to Indian diet is divided, the Sub-Committee should have tried to fill up the gaps in our knowledge before confusing public opinion on the subject Further experiments with germinating and processed beans should be carried out on a sufficiently large-scale to admit of statistical planning and evaluation The population experimented upon should be under controlled observation, keeping notes not only on height and weight, but also on laboratory investigations of blood and urine for vitamin saturation, phosphatic content, X-ray examination of bones, haemoglobin estimations, besides a clinical assessment of the nutritional status.

In the absence of an investigation in India on the above lines and weighing the evidence up to now from scientific literature and experience in other countries, a balanced view on the uses of soya bean would appear to be as follows:—

(*a*) Soya beans, raw or boiled or *cooked by ordinary methods*, probably have no great superior value to Indian pulses. The indigestible nature of soya protein appears to be due to at least two factors: (*i*) presence of a particular type of linkage of its aminoacids (diketopiperazine rings), and (*ii*) presence

of a strong cellulose envelope in the bean which presents, to a varying degree, the action of digestive juices on the protein. Part of this difficulty can be overcome by processing the soya bean before using it for food, like steaming for some time or steaming under pressure It can be expected that, with further advances in processing techniques, the bulk of the protein of soya bean can be made easily digestible

(*b*) A variety of dishes can be prepared from processed soya beans which would suit Indian plate Types of such preparations which are likely to find uniform acceptance among the Indian population are soya milk for infants, children and fermented 'soya milk' or 'curd' or 'butter milk' for adults.

(*c*) In view of the impracticability of stepping up production of protective foods in India to the extent desired for some years to come, soya preparations should be welcomed as additional items to Indian diets

(*d*) The bean lends itself to manifold industrial uses which might be exploited in India

(*e*) It is easily grown at various altitudes. The yield per acre is higher than the ordinary food grains and pulses and it enriches the soil. The cost of growing a soya bean crop is comparatively cheap

CROSSING-OVER

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THE occurrence of variations in the organic world may reasonably be said to depend upon the act of crossing-over, when homologous chromosomes exchange segments during meiosis leading to a recombination of genetical factors Following Janssens' Chiasmatype theory, it is now established that crossing-over is the sole agent conditioning the formation of the cytologically visible chiasma, and this coincidence has provided a powerful tool in the analysis of the genetic make-up of organisms Unassailable proof of this coincidence of genetical and cytological crossing-over is provided by the classic experiments of Stern (1931b), Creighton and Mclintock (1931), and Brink and Cooper (1935).

During meiosis, the nucleus goes through a special form of change, in which two divisions of the nucleus follow one another rapidly, while the chromosomes divide once. The gametes thus receive only half the number of chromosomes that is characteristic of the species. This critical division is believed to operate the mechanism which is not only responsible for the transmission of hereditary characters from parent to progeny but may also account for variations in the latter. At a certain critical stage during meiosis, the threads lie coiled round one another and the paternal and maternal chromosomes exchange portions of their length. This change whereby chromosomes may be reconstituted forms the basic principle of plant breeding. The living world would be shorn of its kaleidoscopic variety if single chromosomes were passed on unchanged.

It is generally accepted that crossing-over occurs at the end of the pachytene stage, when the paired chromosomes divide to give quadripartite structures, *i e.*, the four strand stage. The exact mechanism involved has been the subject of considerable debate and dispute and a number of theories in this connection have appeared from time to time. It is the purpose of this note to review some of these theories in the light of recent additions to our knowledge.

Wenrich (1916) believed that it depended upon the random formation of loops in four associated threads. Belling (1925) sought to explain crossing-over on coincidence of fortuitously occurring breaks in all four chromatids, combined with a movement of torsion and reunion of the newly opposed threads.

Matsuura (1940) in an ingenious theory, postulates that crossing-over takes place at the first meiotic metaphase. He assumes that the paired chromatids of each meiotic chromosome constitute at early metaphase a relational spiral system while those at late metaphase transform into a parallel system. This transformation is made possible by segmental interchanges between the two chromatids, and not by rotation of the distal ends. The major and the minor spirals are assumed to have their own matrices (Fig. 1) Cleavage starts in the minor matrix due to the development of repulsions between the paired centromeres and between the end regions of the chromatids. The cleavage of the minor matrix will alter the parallel conditions of the two threads, a-a and b-b (*vide*, fig. B) into the twisted condition at a certain point. At this point, the stress of torsion due to the progress of the matrix division will cause simultaneous breaks of the two chromatids which

will be followed by reunions In consequence, two new chromatids arise.

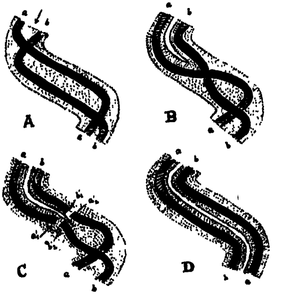

FIG 1
Illustrates the mode of break and reunion between the paired Chromatids according to Matsuura The two Chromatids are enveloped by the minor matrix (stipled) which is further covered by the major matrix (hatched) The minor spiral is omitted

White (1942) suggests that crossing-over may be due to the alternation of heterochromatic and euchromatic segments in which the splitting of the protein framework is not simultaneous (Fig. 2) The two homologues are held together by a pairing attraction while they are unsplit and they are repelled as soon as the split appears. Since the split does not appear simultaneously along the entire length of the paired

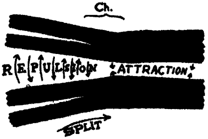

FIG. 2

chromosomes, a tension is bound to develop where a split portion lies adjacent to an unsplit one. Evidence suggests that the heterochromatic segments lag in splitting so that a break and reunion are accomplished due to the alternation of split euchromatic segments which develop strong repulsion and unsplit heterochromatic segments which are still under the influence of a force of attraction. The author derives support for his view from the fact that in certain grasshoppers where there is a localization of chiasmata, the latter are invariably near the regions separating the euchromatic and heterochromatic segments

Among the several hypotheses advanced to explain the cytological mechanism of crossing-over, Darlington's (1935a) is the most elaborate. He assumes that the cause of the formation of the chromonema spirals lies in an internal twist due to a rearrangement of the constituent particles, either between molecules or within them. This molecular spiral or internal torsion leads the threads to coil in an internal spiral in the direction opposite to that of the major and minor coils In the paired chromosomes, each particle is associated with a corresponding particle of the partner The two threads are coiled in such a way that their internal and relational coilings are in equilibrium A directional specificity is assumed which prevents the paired homologues from slipping round each other. This state of equilibrium (the pachytene equilibrium) is the critical stage at which a series of swift changes take place, occasioning a cross-over and the establishment of a chiasma The division of the chromosomes into their component chromatids is the trigger which touches off the critical changes. The daughter chromatids of each chromosome will be relationally coiled in a direction opposite to that in which the chromosomes are relationally coiled The division of the chromosomes also terminates the force of attraction and they tend to fall apart The four chromatids are in a state of tension resulting from the loss of lateral attraction and the diminution of longitudinal cohesion. The strain of coiling results in one of the chromatids breaking The break of one chromatid leads to an upset of equilibrium, which is sudden and the two broken ends will twist round their unbroken sister chromatid thus releasing the coiling strain. This imposes a sudden strain on the opposite chromosome and causes a break in a non-identical chromatid at the same level. The double break will permit the release of the stress by rotation, after which a re-union of the broken ends may take place in such a way that two new chromatids appear. This results in a genetical crossing-over and which manifests itself in the cytologically visible chiasma.

Darlington's hypothesis bristles with assumptions and has therefore aroused formidable criticism. Pairing due to homology is the corner stone on which it rests and up-to-date no satisfactory explanation is forthcoming which would account for this force. Muller (1937) suggested that each gene may set up a specific field of force resulting in auto-attraction between like genes. The force that a body of submicroscopic dimensions may exert cannot, however

be of such an order as would bring together homologues widely separated in the nucleus. Recently, Delbruck (1941) has proposed a theory of autocatalytic synthesis of polypeptides which appears to provide a possible basis for the mysterious pairing force in meiosis. He suggests that self-duplication and two-by-two conjugation of likes have a common basis Delbrück's hypothesis is intended to show how a part of a finished protein or polypeptide molecule containing a given peptide link might become temporarily attached to and act upon the corresponding part of an unfinished combination of aminoacid-like bodies of a similar type, so as to make possible in the latter the completion of the same peptide link. It is suggested that the formation of peptide links proceeds indirectly passing through several steps, beginning with aminoaldehydes The aldehydes link spontaneously to form doublets by making a $-\overset{\overset{H}{|}}{C}=N-$ connection which then hydrolyses to the form $-\underset{\underset{H}{O}}{\overset{H}{C}}-\underset{H}{N}-$ that exists in the precursor In the oxidation of the amid compound to a peptide bond $-\underset{\underset{O}{\|}}{C}-\underset{H}{N}-$, the energy of the radical is believed to be reduced by resonance between states of equal energy This intermediate state would therefore be a semiquinone double chain with a negative charge for each prospective peptide bond which would enter into resonance with the pre-existing peptide linkage group, since they would have identical configurations. In the light of this picture, pairing would amount to an intimate association of the self-reproducing entities within the chromosome coupled with the chemical reduction of each paired pair of peptide bonds, so that each pair would correspond to a set of two resonating structures. Pairing would therefore be locally specific and restricted to twos.

Darlington's idea that a break in one chromatid at a particular level causes a break in another at an identical point has raised considerable physical difficulties. In order to test the validity of this concept, an attempt is now made (unpublished) to examine the forces inherent in a helical system which is in equilibrium under torsion. In a two-strand rope which is held in the form of a helix, the axial force F which will keep it in equilibrium in this form is

$$F=\frac{1}{lr^3}\left[(C\,Cos^2\alpha+B\,Sin^2\alpha)\eta+(C-B)\,Sin\,\alpha\,Cos\,\alpha.\,\theta\right]$$

where l length of rope ; r, α are the radius and angle of helix ; η=axial displacement ; θ=angular displacement at the end of the rope , C, B are constants The tension at any point of the rope is constant and is $J=F\sin\alpha$. η and are proportional to l, so that at any intermediate point θ of the rope, distant l_1 from the fixed end their values are

$$\eta_1=\frac{l_1}{l}\,\eta,\ \theta=\frac{l_1}{l}\,\theta$$

Hence we may also write

$$F=\frac{1}{l_1r^3}\left[(C\,Cos^2\alpha+B\,Sin^2\alpha)\eta_1+(C-B)\,Sin\,\alpha\,Cos\,\alpha.\,\theta_1\right]$$

Assuming that the string is in equilibrium under the action of F applied at its end, and that one of the strands is cut at θ, the torsional couple at that point is annulled and the two ends will revolve in opposite directions It is an essential feature of the theory that the release of the torsional strain is confined to a narrow near the cut. This is based on the assumption of an affinity or lateral cohesion between the two strands Hence we may suppose that the effect of the cut is to cause the two loose ends to revolve through small angles. Since the torsional equilibrium of the rope is due mainly to the co-existence of torsional couples in both the strands which prevent relative torsional movements of the strands, it follows that the local release of the twist in one strand will result in the other also at the same point. This will result in changing η_1 and θ_1, at that point in the uncut strand to new values η_1' and θ_1', which will be less than the original values η_1 and θ_1. The corresponding equilibrium value of F, viz ,F' is given by

$$F'=\frac{1}{l_1r^3}\left[(C\,Cos^2\alpha+B\,Sin^2\alpha)\eta_1'+(C-B)\,Sin\,\alpha\,Cos\,\alpha\,\theta_1'\right]$$

so that $F'<F$

If we suppose that the rope was in limiting equilibrium under F, then it is clear that after one of the strands is cut, it is under the action of F which is more than the value F' required for equilibrium. Hence there is a high probability that the uncut strand will also break at the same point since the tension at that section is greater than the value required for equilibrium.

The situation also admits of another approach. Just before the cut, the force T tending to break the string was distributed over a certain cross-sectional area, say A. It is clear that after the cut, the effective cross section is roughly $A/2$. The resulting stress over the cross section is thus nearly doubled and hence if one of the strands breaks under the original stress, the second also must break at the identical point, under the nearly double value of the stress.

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THE MULTI-PURPOSE DEVELOPMENT OF THE TENNESSEE RIVER

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(Continued from the last issue)

T V.A. Dams and Reservoirs

The major engineering task of the T V A during its existence has been the construction of the dams and reservoirs needed to control and utilise the flow of the Tennessee River and its tributaries.

The headwaters of the river are in the Smoky Mountains and the Blue Ridge Mountains which, with elevations higher than 5,000 feet, are the highest mountain ranges east of the Rocky Mountains The mountain region is in striking contrast to the flat plains drained by the middle Tennessee River which are occupied by large cotton plantations and the rolling lands towards the mouth of the river. The Tennessee River and its tributaries traverse parts of seven States, namely, Virginia, North Carolina, Georgia, Alabama, Mississippi, Kentucky and Tennessee The basin has a population of upwards of 2½ millions people and a variety of natural resources, the most important of which are coal and lumber.

The total drainage area of the Tennessee River at its mouth is about 40,600 square miles and the average annual rain-fall on this area is about 52 inches varying from a maximum of about 60 inches in a wet year to a minimum of about 40 inches in a dry year.

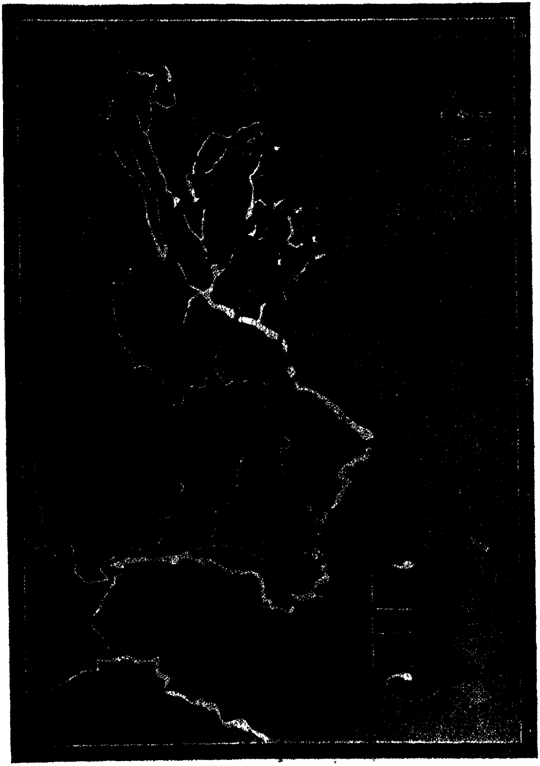
Large floods on the main Tennessee River generally occur only during the winter period from December to April. Approximately 75 per cent of the average stream flow on the Tennessee River runs off during these five months. On the tributaries floods due to local cloud bursts may occur at any time during the year

T V A Plan of Development

General Consideration Construction of dams to control the river is not an end in itself; it is only a means to make it possible to achieve the general aim of safeguarding the security and welfare of the people.

A broad programme of unified river development as laid down in the T V A. Act, should have in view, in order to be most effective, not only the functions of the Federal Government but also the proper relation of these functions to those of State and local Governments as well as private enterprise. The T.V.A. Act provides that the authority should attempt to co-ordinate and unify the efforts of the other agencies in the Valley which otherwise would be without such instrumentality.

Benefits that are not possible to any one State or for any one purpose may be possible through combination of several types of activities, or the activities of several agencies. Construction of highways and railways may interfere with the natural drainage of the land and create undesirable swamps. Large factories located in one State and providing useful employment there may discharge harmful effluents into the river and render the water unusable to the inhabitants of downstream localities in another State. Creation of reservoirs may make adjustments in agri-



cultural methods of downstream cultivators desirable for best results or the downstream cultivators may require a certain type of operations at upstream reservoirs which may be in partial conflict with power and flood control requirements.

Only with the active assistance of some planning and co-ordinating agency are satisfactory adjustments fully possible in all these and similar problems

Principal Features · In some respects development of the Tennessee River is part of a larger plan. Flood storage reservoirs in the Tennessee basin play an important part in the control of floods on the lower Mississippi River and the 650 mile stretch on the Tennessee River with a nine-foot navigable depth ties in with some 5,000 miles of similar navigable channels on the Mississippi River and its tributaries, another 2,500 miles of navigation channels with a minimum navigable depth of 6 ft. and more than 1,000 miles of channels with a minimum depth of four feet

A broad outline for the unified development of the Tennessee River and its tributaries was prepared shortly after the authority's inception and this plan has been closely followed in all its main features

At the time of the creation of the T.V.A in 1933 two major developments were in existence on the main Tennessee River, namely the Wilson Dam operated by the U S. Corps of Engineers and the Hales Bar Dam which at that time was owned and operated by a private power company. In addition, two small navigation dams were in operation, the so-called Lock and Dam No. 1 immediately below Wilson Dam and the Widows Bar Dam below Hales Bar On the tributaries the Aluminium Company of America owned and operated three dams, the Santeetlah, Cheoah and Calderwood developments, in the Little Tennessee River basin. Private power companies operated the Waterville Project on the Big Pigeon River and three plants on the Ocoee River, while some smaller plants were also in operation on the French Broad, Hiwassee and the Watauga Rivers

T.V.A.'s problem on the main Tennessee River consisted of—

(*i*) Developing a series of dams which would provide a 9 foot navigable channel from the mouth of the river at Paducah, Kentucky, to Knoxville, Tennessee ;

(*ii*) Providing as much flood control as feasible ;

and (*iii*) Developing the maximum amount of power consistent with the requirements for navigation and flood control.

The T.V.A. engineering problem was no longer a case of an isolated development built for one particular purpose, but it was rather a matter of determining the most economical system which would accomplish all the objectives

Some of the considerations which led to the selection of the recommended plan of development on the main Tennessee River are—

(*i*) Feasible dam sites for large projects on the main Tennessee River were decidedly limited by the small number of locations at which satisfactory topographical and geological conditions could be found ;

(*ii*) Navigation requirements dictate a series of pools to step up the water level from approximately elevation 302 at the mouth of the river to elevation 807 at Knoxville, Tennessee ,

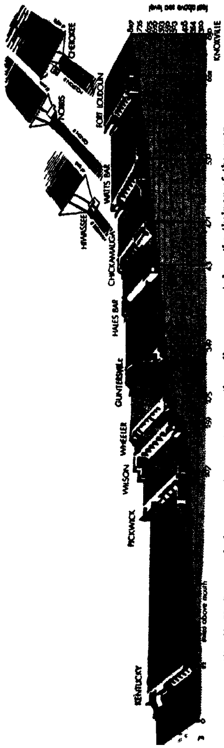
(*iii*) The minimum pool levels for each reservoir should be at an elevation which would provide a 9 foot channel immediately below the next project upstream ,

and (*iv*) The maximum reservoir level and therefore the amount of flood storage which could be provided at each project is limited by the amount of compensation involved in land acquisition and damages to cities, utilities, railways and highways

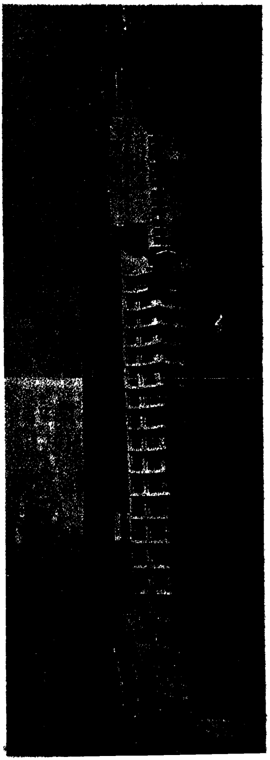
Economic comparisons of several possible combinations of developments led to the selection of the main river system of dams which is now in operation

Proceeding from the mouth of the river upstream the minimum water level is successively raised by the Kentucky Dam from elevation 302 to elevation 354 ; by the Pickwick Landing Dam to elevation 408 ; by the Wilson Dam to elevation 504½ ; by the Wheeler Dam to elevation 550 , by the Guntersville Dam to elevation 593 ; by the Hales Bar Dam to elevation 629 , by the Chickamauga Dam to elevation 675 ; by the Watts Bar Dam to elevation 735 ; and by the Fort London Dam to elevation 807. The flood storage space provided at these dams above minimum reservoir levels amounts to about 6,200,000 acre-feet. The total power installation at the dams is about 1,156,000 K.W. and provision has been made at the power stations for the additional installation of another 508,000 K.W.

The type of development constructed on the main river was quite similar in all cases. Following recommendations of the Chief of Engineers, United States Army, the size of navigation locks was made 110 ft. by 600 ft. for projects below Wilson Dam, with a provision for later addition of a 60 by 260 ft. lock. Above Wilson Dam new locks were made 60 by 360 ft. with provision for the later construction of a larger lock. The spillways of main river dams in every case were located near the centre of the structure with a view to causing as little disturbance as possible to the downstream natural river channel and because of the limited space available to accommodate



The T V Dams a d their respective positions in the valley as projected on the thalweg of the river



Chickamauga Dam on the main river, the lock gate and the power house on the left and the right extreme

all structures, including locks and powerhouse intakes, the spillways were shortened as much as feasible by deepening the spillway gates. The width of individual spillway gates was fixed at 40 ft. which was considered to be the minimum width for safely passing the large quantities of drift which accumulate during extreme floods. This width was also considered to be the maximum economical for the depth of gates required, because mechanical difficulties would increase rapidly for weights greater than those already involved Due to excessive amounts of submergence vertical lift gates were required at some of the projects, whereas at other projects where submergence was not a factor radial gates were generally used

The overflow section of the dams was built of concrete and at most of the dams the depth of overburden and the width of flood plains dictated the use of earth embankments on either side of the spillway The powerhouse and the lock sections of the projects were generally located on opposite sides of the river.

The problem on the tributaries was different from that on the main river and the selection of projects was controlled mainly by considerations of flood control and regulation of minimum streamflow. Topography and geology at many sites were found to be generally favourable for the construction of dams, but the height to which dams could be built was limited in many cases by existing communities and facilities such as highways and railways. Extensive economic studies led to the selection of the Norris Dam on the Clinch River, the Cherokee Dam on the Holston River, the Douglas Dam on the French Broad River, the Fontana Dam on the Little Tennessee River, the Hiwassee, Apalachia, Chatuge and Nottely Dams on the Hiwassee River and tributaries and the Ocoee No. 3 Dam on the Ocoee River, where the Blue Ridge Dam and Ocoee Nos. 1 & 2 Dams were already in existence. In addition, the Aluminium Company of America extended their existing three-dam system with two additional dams and operations at all five dams is being controlled by the T.V.A. The total usable controlled storage volume above minimum pool levels at all these dams amounts to about 8,600,000 acre-feet. The total drainage area controlled by reservoirs on the tributaries is nearly two-thirds of the drainage area above Chattanooga, the principal point of flood hazard on the Tennessee River. The total installed power capacity at the tributary plants is about 1,012,000 K.W. including 307,000 K.W. at the Aluminium Company's dams.

Provision has been made for the additional installation of approximately 266,000 K.W.

The type of development constructed on the tributaries was determined mainly by the topography and geology of the site as well as the availability of materials at the site suitable for construction purposes. Because these conditions are different at practically all the sites on the tributaries, the only similarity which can be observed is in the spillway gates and powerhouse equipment and layout.

Some dams like Hiwassee, Fontana, Apalachia and Ocoee No 3 dams are all-concrete gravity dams. Others, for instance, Norris, Cherokee and Douglas dams have a central concrete overflow structure and are flanked by earth dikes, while the Chatuge dam is a rolled earth-fill structure and the 190 ft high dam on the Nottely River is a rock-fill dam with a centre core of rolled clay fill

In all the T V.A structures great economy was obtained by standardization of design Hydraulic structures, generating units, mechanical equipment, gates, cranes and accessories were designed not only for the particular project under consideration but also to permit repeated use on successive projects

In twelve years the T V.A constructed sixteen dams and a large thermal electric plant of which fourteen dams and the thermal plant were designed by T V A engineers The first two dams, Norris and Wheeler, were designed by the Bureau of Reclamation engineers because it took some years to build up an organization capable of designing structures of the magnitude involved

All sixteen dams and the thermal plant were constructed by the T.V A construction department with its own engineering and labour forces. Building of these dams involved placing almost eleven million cubic yards of concrete and about twentytwo and one half million cubic yards of earth and rock fill. To illustrate what these quantities mean, it can be stated that the amount of concrete placed would cover an area of one square mile to a depth of ten and one half feet, and the earth and rock fill would cover one square mile to a depth of about twentyone and a half feet

These are large quantities and the amount of work involved could not have been achieved in such a short time if any detail had been left to chance. Time schedules were prepared for the design of each particular feature of each project, so that drawings would be available when needed, and similar schedules were made for preparation of equipment specifications, manufacture, delivery and erection of equipment ; for procurement of construction materials and equipment, and for the construction operations themselves in their logical sequence. These time schedules were rigidly adhered to so that the time of completion of a particular project could be predicted with certainty many years in advance.

At the peak of employment the total number of T.V.A employees amounted to more than 40,000

Great economies were obtained by T.V.A.'s policy to construct its projects with their own forces and equipment. Labour became more expert at their tasks as a result of a training programme and as they gained experience. Construction equipment instead of being sold after the completion of a project was used over and over again on successive projects The value of equipment transferred from project to project is estimated at about 3 2 crores of rupees ; if purchased new this same equipment would have cost some 6 crores of rupees.

The top layer of rock is generally fractured and dis-integrated and has to be excavated before sound rock suitable for foundation of a dam is exposed in the excavated area. The depth of rock excavation at T.V.A. dams averaged about 25 feet varying from an average of 5 feet at one dam to an average of about 45 feet at another project.

Preparation of Reservoir Site

One of the most important activities in connection with large water control projects is the preparation of the reservoir area The first step for this pre-

Cherokee Dam and the lake.

At some of the projects, particularly those on the main river, considerable difficulty was experienced with the foundations for the dams. These difficulties were not unexpected as during the preliminary investigations each dam site was thoroughly investigated by an extensive programme of exploratory drilling, resulting in rather complete knowledge of sub-surface conditions. At some of the dams large cavities, 10 feet or more in height, located underneath the river bed, had to be sealed off, cleaned out, filled with concrete and grouted with cement in order to obtain a satisfactory foundation for the dams.

paration is the acquisition of the land. Accurate surveys of the area are prepared showing the elevations to which the water will rise and the boundary of the properties within the area The fundamental policy which underlies the acquisition of land is that the Authority through a Board of Appraisers fixes a uniform price for properties in the same classifications and no purchases are made above or below this price. If the owners are unwilling to convey the property at the appraised price the property is condemned and the price is then established by the Courts. Less than 5 per cent of the acquired pro-

perty has been involved in condemnation proceedings. Land acquisition is begun when the project is authorised for construction but the owners do not have to vacate their land until the dam is completed and the filling of the reservoir is started. At most projects there is a period of several years after the start of construction before the land has to be vacated. All possible assistance is given to the population of the reservoir areas in locating new farms and help them in making satisfactory agricultural readjustments. A total of more than 12,500 families has thus far been removed from reservoir areas

In addition to the land acquisition and family removal, many other adjustments are necessary in the reservoir area before the reservoir site is ready for filling. In many cases highways and railways will have to be relocated and this is generally achieved in co-operation with the State highway officials and the railway companies concerned. Many important bridges had to be rebuilt, raised or built anew.

In order to minimise the incidence of malaria the shore lines of the reservoirs are cleared and areas where pools will be formed upon recession of the reservoir levels are drained. Some areas along the reservoir shore lines which might become swampy are filled or graded, or diked off and provided with pumps In many cases readjustments have to be made in the communities affected by the creation of new reservoirs. Generally these are in the nature of changes in grade of sewage outlets and adjustments to water supply intakes. In some important cases however, large dikes had to be built around existing communities and a pumping system supplied for drainage of these communities.

In order to prevent unsightliness and to improve malaria control as well as to provide for boating on the reservoir area the reservoir lands are cleared of all trees and structures to an elevation of approximately 10 feet below minimum water level. In so far as it is economical to do so, the lumber obtained from these operations is salvaged and sold. Clearing of the reservoir areas also prevents debris from rising to the surface and creating a problem in its later removal.

Labour Relations

An Authority with a magnitude of tasks such as those of the T.V.A has a large number of employees and labour of all kinds and grades. In order to foster good relations between its employees and management the T.V A has developed a definite policy over a number of years. This policy recognises the right of employees to organize, affiliate as they choose, designate representatives and bargain collectively with the management. In this connection the Authority signed a general agreement with the Tennessee Valley Trades and Labour Council which is composed of trade unions affiliated with the American Federation of Labour. This agreement included schedules pertaining to hours of service, working conditions and wage rates for employees represented by the council. Other agreements provided for effective and rapid handling of jurisdictional questions, employees' grievances and labour disputes.

I should also mention that the T.V.A. Act requires the Authority to pay the prevailing wage rates in the vicinity with due regard for rates secured through collective bargaining agreement. Under the T V A. labour relations policy there have been no work stoppages of any consequence. Salaried personnel too participate in collective bargaining activities. Some seven organizations are represented on a Salary Policy Employee Panel which represents all salaried employees for collective bargaining purposes

Reservoir Operation

In the planning and design stages of the projects the multi-purpose function of the dams has been kept constantly in mind and the multi-purpose uses of the project also played an important role in determining the priority of construction of the dams. The same multi-purpose functions are the determining factor in the operation of the reservoirs.

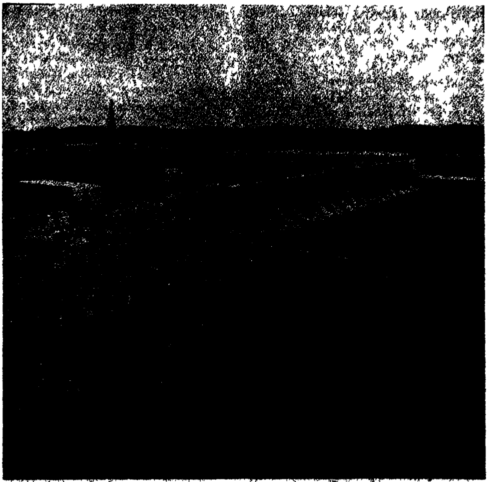
On the main Tennessee River the lower portion of the reservoirs must remain filled to maintain slack water pools required for navigation. At the same time, maintenance of such pools creates a head at the dams which can be utilised for power purposes. At the upper end of the navigation pools the depth of channel is at times only barely sufficient for navigation and a steady regulated streamflow is required to maintain the navigable depth and eliminate costly dredging operations. This regulated streamflow is also utilised as a steady source of electrical energy. In its passage from the headwaters to the mouth of the river the water released from tributary projects for streamflow regulation thereby performs a manifold duty.

The upper portion of the main Tennessee River reservoirs above the navigation level is reserved for flood control purposes during the season when destructive floods occur on the Tennessee River from December to April of each year. In advance of a flood, during rising stages in the Ohio and Mississippi rivers and with sufficient water flowing in the Tennessee River to maintain depths in the upper reaches of the reservoirs, the water levels at the dams may be lowered below that normally maintained for navigation during the dry weather season. This operation is performed in order to make addi-

tional flood storage capacity available when the crest of the flood approaches

As the flood control season draws to a close and the danger of destructive floods is greatly diminished, some of the storage space downstream from Chattanooga, which is the point of greatest danger on the Tennessee River, may be gradually filled At the end of the flood season additional storage space at the main river reservoirs may be filled to strand flotage and facilitate the control of malaria breeding mosquitoes The cycle of reservoir operations at the main river dams is completed during the summer season when stored water is gradually released until the low navigation level has been reached

For flood control purposes the function of the tributary reservoirs is more important than that of the reservoirs on the main river The tributary reservoirs reduce the size of major floods to floods of manageable proportions and the tributary reservoirs are therefore useful not only for the Tennessee River floods and local flood protection, but also for Mississippi River flood control The availability of storage capacity at the tributary reservoirs is timed so as to make the greatest amount of storage space available when the danger of successive floods on the Tennessee River is greatest As the flood season advances, the necessity for flood storage space diminishes and the reservoirs may be gradually filled until at the beginning of the summer period there is only sufficient storage space available for the control of summer floods At minimum reservoir levels sufficient space is provided for silt storage and at the same time sufficient head is made available for economical power production Water stored above minimum reservoir levels during and after the flood season is released during the period to benefit navigation and power production



Watts Bar Dam. Boats are lifted a 70-ft. step in the Tennessee River navigation system Water is seen boiling from the power house generators

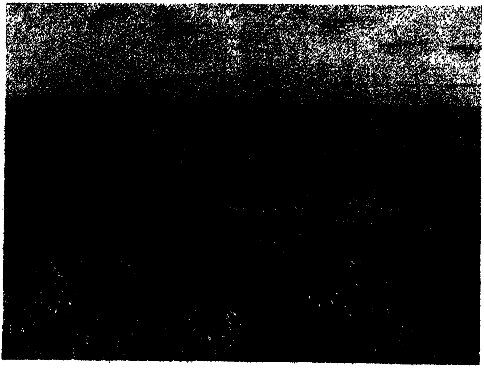
A powerhouse is provided at each of the

Authority's dams to utilise the flow resulting from these reservoir operations and the power which thus becomes available is the amount of power which can be economically obtained after the primary purposes of navigation and flood control have been satisfied. If the dams and reservoirs were to be operated for power purposes only, an increase of about 25 per cent could be obtained in the amount of power which can be made available continuously. During the war period some of the multi-purpose dams were operated in this manner with the foreknowledge of the Congress. These dams have now reverted to their normal multi-purpose functions.

During the wet season of the year, tributary reservoirs are filled, releases are kept to a minimum, and the major amount of power is produced at main river dams. During the dry season the process is reversed.

Even after regulation of the streamflow by the reservoirs, more hydro-electric power is available during wet seasons than during dry seasons or years. So-called "secondary power" which is the power in excess of that which is continuously available generally does not find a ready market. Only additional installation of generating equipment at the dams is required in order to obtain this type of power and it is therefore generally quite economical. In the T.V.A. power system as well as in most other systems it proved economical to supplement the secondary power with thermal stations and thereby increase the amount of saleable continuous or primary power. Such combination of hydro and steam generated energy is usually the most economical source of power supply. The total generating capacity installed at thermal electric stations in the T.V.A system now amounts to about 430,000 K.W., including a 240,000 K W station at Watts Bar built by the T.V A

In addition to their major multi-purpose functions the reservoirs have a number of quite important secondary uses. Foremost amongst these are recreation and fisheries Thousands of pleasure craft ply the rivers and the lakes, many public recreation parks dot the shorelines and these are operated by privates and by States, Counties or cities Fishermen come from all parts of the country and fishing is a thriving industry, which in 1943 produced more than six million pounds of edible fish and is expected to increase manifold.



Guntersville, Alabama, became an inland port when the dam was built. Formerly it was only a 'sleepy market town'.

Activities Related to the Main Programme and the Applicability of T.V.A. Methods to Indian Rivers

It is somewhat of a misnomer to call the building of the dams the T V A.'s main programme, and to say that other activities are merely related thereto That is only an engineer's point of view and it could only be considered true during the construction period which is now drawing to a close

I have only time to barely mention the T.V.A 's other far-flung activities which in the future no doubt will prove to be its main programme. However, even a mention may give you a better idea of the magnitude of the task ahead.

T.V A Organization and Activities

Probably the most systematic way of describing these activities to you is to follow through T V.A.'s organization chart with a brief description of the tasks of the various departments I have already mentioned that the T V.A. is directed by a 3-men "Board of Directors" appointed by the President of the United States The Board is advised on all legal matters by a "General Counsel" and instructions of the Board to the organization are executed through the office of the General Manager. This department is responsible for the co-ordination of all the tasks of the Authority and is aided by a Budget Office which prepares the T V A 's annual budgets for submission to the Congress, and an Information Office in charge of all publicity and press releases.

Most of T.V.A 's activities are centered in various departments—17 in number—in addition to those already mentioned. Grouped under a Chief Engineer are three engineering departments dealing with "water control in the river channel", these are, the Planning Department, the Design Department and the Construction Department. The activities of these three departments need no further description. Grouped under a Manager of Power are three Departments, namely, the Department of Power Utilization, the Department of Power Engineering and Construction, and the Department of Power Operations. The Department of Power Utilization prepares electrical load surveys, fixes rates and terms, promotes the use of electricity and attends to all business transactions in connection with the sale of electricity. The Department of Power Engineering and Construction attends to the erection of transmission lines and sub-stations, and the Department of Power Operations is in charge of the operation and maintenance of all hydro-electric and thermal power plants including despatching of the load.

Grouped under a Chief Conservation Engineer are three departments which deal with "water control on the land". These are the Department of Agricultural Relations, the Department of Forestry Relations, and the Department of Chemical Engineering The Department of Agricultural Relations co-operates to the fullest extent possible with existing Federal and State agricultural agencies to promote growing of crops best suited to protect the top soil, best use of the land and enrichment of the soil by the application of proper fertilizers. A significant part of the programme is that when the top soil is protected by adequate crops, silt in the river will be reduced and the capacity of the reservoirs will be kept intact for a longer period The T.V A.'s agricultural programme may eventually have far reaching effects and the number of test demonstration farms is growing year by year Test demonstration activities are of two kinds, that is, test demonstration farms and test demonstration areas The unit test demonstration is carried out by an individual farmer who receives T.V A. fertilizer for the cost of freight and handling and in return he follows a pre-determined plan for his farm worked out in co-operation with his county agent and agrees to keep adequate records. In 1945 there were some 35,000 test demonstration farms in 28 States of which 30,000 were in the Tennessee Valley States. In the area test demonstration an entire community embarks upon a programme of agricultural development and watershed protection.

The Department of Forestry Relations encourages afforestation in the valley in co-operation with other Federal and State agencies. The Department operates a number of tree nurseries for experimental purposes where some 25 millions of tree seedlings are produced annually. Another function of the Department is to plant trees in the reservoir areas to assist in the prevention of soil erosion, and to distribute seeds and seedlings to farmers for afforestation purposes of land which is deemed unsuitable for agricultural purposes.

The Department of Chemical Engineering operates a group of chemical plants for the manufacture of phosphates and ammonia fertilizers. During the war these plants manufactured pure phosphorus and ammonium nitrate for military uses. The Department also operates a number of laboratories and pilot plants for the development of new processes in the manufacture of fertilizers.

The remainder of the departments are not grouped but are operating as independent units. These are—

(i) The Personnel Department which is charged with employment matters and training of the T.V.A. personnel. The T.V.A. employs personnel in almost every field of human activity ranging from scientists and specialists to ordinary

workmen The employees are scattered over a large area in big cities as well as in remote river valleys. Administration of the personnel and keeping of adequate service records is a complicated task. In the T.V.A it is recognised that competent personnel and good personnel relations are major factors in the success of the organization.

(ii) The Finance Department is charged with all financial record which includes general accounting, auditing, power accounting, chemical accounting and construction accounting.

(iii) The Legal Department's duties include preparation of Court cases such as the "Ashwander Case" and the "18 Companies Case" which I have already mentioned, opinions regarding the applicability of labour laws, as well as condemnation proceedings for land purchases in connection with the building of the dams and preparation of legal contracts such as power contracts and agreements with neighbouring power systems.

(iv) The Department of Property and Supply handles purchases of materials for various departments of the T.V.A. ranging from power equipment to office supplies and stationery This department also is in charge of land acquisition and land sales.

(v) The Regional Studies Department investigates and surveys economic and social conditions in the valley and formulates plans for their betterment. The department works largely through established local governmental units and organizations.

(vi) The Health and Safety Department is in charge of malaria control and enforcement of public health measures and safety regulations at construction projects. The department establishes dispensaries and hospitals in places where there are no adequate hospital facilities. Malaria control is achieved generally by adequate treatment of the shore lines of the reservoirs, by fluctuation of the pool levels, by spraying with insecticides and by education of the people in effective ways of preventing malaria. The number of malaria cases in the valley has been steadily decreasing during the last decade.

(vii) The Commerce Department does research and promotion work for improving the quality and marketability of products grown in the valley and for bettering the navigation facilities of the river. Included in its activities are promotion of establishment of refrigeration and dehydration facilities in rural area so that perishable products may be preserved and marketed. The department also has worked out improvements to a number of farm implements and agricultural machinery adapted for use in the valley and has prepared literature to instruct farmers in the use of electricity on the farm. In order to improve navigation facilities in the river the Commerce Department operates the river terminals including its warehouses Complete records are kept to assist in establishing fair rates for this service The department furnishes all possible assistance to business organizations in the valley for shipment of their products and materials.

(viii) The Reservoir Property Management Department is generally charged with the proper development of T.V A property in reservoir lands. Included in its activities are fish and wild life development, development of commercial fisheries in the reservoir areas and development of recreational use of the reservoirs including development of park areas, pleasure boat docks and fishing camps.

In this brief description it has not been possible to mention in detail many significant activities of the Authority and for those who are interested, I would recommend reading "T.V.A. Democracy on the March" by David A Lilienthal, Chairman of the T.V A. and of the T.V.A.'s Annual Reports. For instance, in leafing through the 1943 Report I notice a reference to experiments with phosphatic fertilizers conducted at the King Ranch in South-Western Texas. Two pastures, each one square mile in size, were fenced in, one was left unchanged, while the other was given an application of 150 lbs. of T.V.A. Super Phosphate per acre. At the beginning of the experiment the heifers on the two pastures averaged approximately the same in weight. At the close of the first year the average gain per animal on the phosphated grazing land, which carried about 45 per cent more stock, was 87 lbs., greater than that of animals on the unphosphated land. The total gain in weight of the animals on the phosphated land was slightly less than twice that on the unphosphated land. In the 1945 Report there is a reference to the relationship between soil conditions and human nutrition. The experiment, which is to run for five

years, seeks to determine the effect of treatment of the land on the health of the farm people This is believed to be the first attempt in this direction in the history of nutrition research and in the experiment the T.V.A is co-operating with five other agencies. Co-operation of the T V.A. with other agencies is evident throughout all reports.

I do not have the exact number but I do not think that it would prove to be an exaggeration to say that the T.V.A has co-operative agreements with more than 500 agencies, including universities, private business and sub divisions of the country, State and Federal Governments I would also reiterate that the T V.A. is not superseding any services rendered by existing agencies It merely attempts to co-ordinate the use of their services and fills gaps where there are gaps A visit to the Tennessee Valley would be more convincing than anything I could tell you and that may be outside the realm of possibility for many of you, and some would still be left in doubt whether similar development could be undertaken in India The most convincing demonstration can be brought about only by a similar development here modified in so far as is required to meet local needs That is the way the T V.A was started In the words of President Roosevelt in his message to the Congress in 1933 asking for the creation of a Tennessee Valley Authority :—

"Many hard lessons have taught us the human waste that results from lack of planning Here and there a few wise cities and counties have looked ahead and planned But our Nation has "just grown" It is time to extend planning to a wider field, in this instance comprehending in one great project many States directly concerned with the basin of one of our greatest rivers

This in a true sense is a return to the spirit and vision of the pioneer If we are successful here we can march on, step by step, in a like development of other great natural territorial units within our borders."

Applicability to India

There can hardly be any doubt about the success of the experiment in the Tennessee Valley and similar developments in other river valleys in the United States seem to be on the way. The question now is "Can this type of development be applied elsewhere in the world and particularly here in India?"

In any departure from established methods there are always many doubts and many times during my stay here I have heard it said "We have always done things this way, why should we change?" The sentiment thus expressed is quite natural In an old and heavily populated country such as India the pressure upon the resources is so great that men tend to become resigned to conditions and hopeless of doing much to better them. Nevertheless it seems reasonable to examine what is meant by "always".

Geologists tell us that the age of the earth is about two billion years, basing their estimate upon what they know about certain elements which gradually break down into certain other substances. That is, not as the world we know to-day, but as a separate sphere whirling about the sun. The heat of the sun weathered the bare surface, created stresses and strains and formed mountains and depressions. Somehow plant life appeared on this surface and much later man made his first appearance. It is not known when this happened but the earliest remains now known are those of Pekin man which are about 500,000 years old or 1/4000th of the age of the earth. In all probability animal life came some time earlier but when man first appeared in any appreciable numbers destruction of the "good old earth" really started There are evidences that even Pekin man knew how to build fires, but it is not known whether he bothered to put out the fire after it was started. Men have inhabited this earth for only a comparatively short period of time as time is measured in geologic age. During that time man has managed to effect a prodigious amount of destruction. Some portions of the earth because of favourable climatological conditions became more densely populated than others and consequently destruction has progressed more rapdly on some portions than on others, for instance, here in India and in China. That does not mean that there is comparatively little destruction elsewhere, on the contrary there are many other factors besides population which contribute to destruction In the United States which is not as densely populated as either India or China, we managed to destroy in a much shorter period as much or more in certain localities as was done here or in China. We used machines to do it, machines which tore down forests at such a terrifying rate that the logs clogged the rivers and dynamite had to be used to get them moving again. I am sure that you have all seen pictures of the log jams in the rivers and of the lumber camps which were the source of much good clean fun to many people, but when the fun was over devastated areas, abandoned lumber camps and towns were left, leaving also a problem for the next generation to solve. With the destruction of the forest cover, erosion started, the river beds silted up, water ran off from the denuded ground at a greater rate, and more land was rendered useless in great floods.

However, generally destruction has progressed farthest where most men were the longest which almost paraphrases a famous military slogan "Get there fastest with the mostest". Meanwhile by indiscriminate use and consumption of the reservoir of natural resources which had been created for millions of years before his appearance, man managed

to live and multiply. This process cannot "always" continue and this "always" applies to the future and not to the past A reservoir is not inexhaustible and when the use continues to grow there is a point where the ever-converging lines of supply and demand cross each other. Logically, the first evidences of such occurrence would manifest itself in the heaviest populated places, in other words, in India and China and particularly shortly after periods of the heaviest destruction, destruction created by extended periods of drought, by floods or by man-made war. Incidentally droughts and floods probably also are intensified by man's destruction of the forest cover Such evidences have become more frequent even during our lifetime. Each time we experience an extended drought here in India, there is a famine and now after a particularly destructive war famine threatens all over the world.

It seems clear that the trend must be reversed and this can only be achieved by conservation and systematic development of natural resources It must also be realised that India is no exception and there may be some justification in concluding that conservation is a greater need here and in China than almost anywhere else in the world

I think it is also true that the same methods can be employed here as have been employed successfully elsewhere in the world. Water is the life blood of an agricultural country, water and soil, a strong soil not an exhausted soil, a soil built up with fertilizers so that many good crops can be grown, many good crops and not one poor crop, thus producing abundant food for the population as a whole.

A start can be made at any time and the sooner it is made the better Plans have been made, plans modelled after the T.V.A , for the development of the Damodar Valley next door to Calcutta, and plans are under consideration for other valleys too. Such plans aim to convert destructive running water into a servant of mankind by means of controls at key points in the river valleys.

The Damodar Valley plans provide for seven storage reservoirs with hydro-electric power houses at each dam, one diversion dam for power purposes and one barrage for irrigation purposes. The reservoirs will reduce floods to manageable proportions and release water the year around for irrigation of three quarter of a million acres and for generation of power The total power installation including thermal station capacity will be about 350,000 kilowatts. With the continuous flow of water in the river navigation from Calcutta to the coal fields will become a possibility and ample water will also be available for industrial and domestic water supply purposes. In other words, the Damodar Valley with its wealth in minerals, with power and water assured and probably with a means of economical transportation could easily become an outstanding industrial valley. However, the foundation must be laid, business needs a solid ground on which to build

It would seem to be self-evident and sound that comprehensive plans of this nature must be made on a watershed basis and that the principal aim must be to promote human welfare There is no reason why local, Provincial or States rights cannot be safeguarded in the execution of the plans. Co-operation is necessary and should be forthcoming with full realization of the waste involved in postponing development of sources of potential wealth.

NUTRITIONAL REQUIREMENTS OF PLANTS

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ESSENTIAL ELEMENTS

NUMEROUS investigations in the past two decades have changed the concept of *ten essential elements* and added the importance of others like *Boron, Copper, Cobalt, Manganese, Iodine, Vanadium* and *Zinc* which are required in minute quantities for plant growth and development These elements are required in traces or minute quantities and known as trace or minor elements , their absence from the culture media has got profound effect on plant nutrition and ultimately on animal nutrition Recent researches have shown that the content of trace elements in plants is of great significance in animal nutrition as absence of some of the trace elements results in serious malnutrition of animals

Common causes of physiological disorders or deficiency diseases are deficiency of nutrient elements, excess of nutrient elements, toxic concentration of salts in soil and unfavourable soil-water relations and climatic factors. In India very little work on the nutrition of plants has been made It is suggested that physiological cause of plant diseases that are of wide occurrence in India may be traced to the absence of proper nutrition of elements in the diseased plants. Researches on the importance of trace elements in plant growth need no doubt highly refined methods of chemical analysis requiring the assistance of a good chemist, but at the same time it is to be borne in mind that the co-operation of a plant physiologist in assessing the effects is very necessary.

NUTRIENT DEFICIENCY

A good deal of work on the mineral deficiency of crop plants and fruit trees has been done in the West. Characteristic symptoms due to deficiency of elements are fairly well known. But the effects of mineral deficiency on growth and metabolic processes of rice and fruit trees in India are very little known. Deficiency of nutrient elements has got profound effects on the metabolic processes of plants A knowledge of the effects is essential for agriculture associated with fertilizer practices.

Experimental methods for studying the effects are the use of sand and solution cultures. These methods have been used in the West to study the deficiency symptoms which serve as a guide for the effective use of fertilizers. As the mineral deficiencies are related to the general plant environment, light intensity, temperature and soil conditions, sand or solution cultures under controlled conditions are adopted to evaluate the effects of a nutrient deficiency Much can be gained for the benefit of Indian agriculture by using these methods for crops grown under local conditions

PLANT NUTRITION

The problems of plant nutrition are very complex and need planned researches on the specific requirements of plants. It is a wellknown fact that nutrient requirements of varieties of crop plants vary under different environmental conditions. Differential response to the use of nutrients by different varieties of crop plants has been shown in many cereals Application of manures in the West is based on the requirements of crops grown under different environmental conditions Unless the requirements of crops in different localities are known the application of artificial fertilizers in India will not bring an increased yield. Precise information on the nutrient requirements of plants could be obtained by the analysis of different parts of plants at different stages of growth and development as the plant is the living integrator of the entire system of atmosphere—plant—soil. But very few attempts have been made in India to study the absorption of nutrients by plants, while greater attention has been paid to soil analysis.

In the field of researches on plant nutrition the most interesting developments are the mutual relationship of nutrient elements and their interrelations with the environmental factors. Numerous evidences are available to show the interaction of elements like nitrogen, phosphorus, potassium, calcium and iron in plant growth The role of root system is receiving increasing attention in the problems of plant nutrition. Absorption and accumulation of salts is related to the absorbing surface of roots and their penetration. The phenomenon of ionic exchange and desorption of cations is due to a competition between soil colloids and colloids of the root cells. All these considerations emphasize the need of a study of root system in the nutrient requirement of a crop. The influence of light and temperature on the nutrition of nitrogen, potassium and boron in plants has been shown. Warington (1937) has demonstrated boron deficiency at various lengths of day and in respect to

legumes and cereals the deficiency symptoms are less pronounced under short day conditions than under long day conditions. Interaction of light on nitrogen and potassium is evident from a consideration of the role of potassium in carbon assimilation and the relation between sugar and nitrogen in the synthesis of protein. Recent investigations by Gregory (1937) and his School in England and Grassner and Goeze in Germany have demonstrated interaction of nutrient elements between themselves and with light duration. From the results of Gassner and Goeze (1933-34) it appears that when light duration is not limiting, a direct relation between nitrogen supply and assimilation can be demonstrated. With short days of three hours per day light is limiting and no response to nitrogen is noticed With normal light duration the effects of increased nitrogen supply increase with age

Nutrition of Rice Plant

Studies on the physiology of rice plant made by me for the last few years have revealed interesting results on nutrition of rice plant. Absorption of nitrogen, phosphorus, potassium and calcium is known to vary in different varieties under different climatic conditions in India Observation made by Sen (1916) in Bihar show that by the time flowers of *Aman* paddy appear the assimilation of N P and K is fairly complete and the amount of plant food materials taken up after the formation of ears is negligible. These have led to conclude that the manures should be applied at early stages On the other hand absorption of N. P. K. and Ca by one variety of *Aman* paddy in Bombay (*Sahasrabuddhe*, 1928) is continued upto the ripening period and does not stop when flowering period begins. Assimilation of nutrients is further increased at the "milk" stage, and accordingly manures should be given in such a way that they will be available to the rice plant not only at the beginning but also at the flowering and "milk" stage. The effect of sodium nitrate is found to vary with the nature of paddy used in the same locality (Dastur, 1940) In some transplanted varieties the yield is high with sodium nitrate alone while with broadcast paddy the use of sodium nitrate has depressed the yield A consideration of these results emphasizes the need for carrying out investigations on the salt requirments of the varieties of rice grown under different environmental conditions

Nitrogen requirement of rice plant is an important problem of agriculture in India. The belief that nitrate alone is not suitable for growth of rice plant needs modification in the light of researches conducted by Willis and Carrero (1923) and more recently by Asana (1945). Poor growth and chlorosis that are associated with nitrate cultures were found by Asana to be due to the source of iron. With suitable source of iron, ferrous sulphate, he was able to grow plants in a nitrate culture upto the flowering stage and a relationship with nitrogen uptake and light intensity was also noted.

An evidence for the existence of interaction between nitrogen and phosphorus has been obtained by Sircar and Sen (1941) in some manurial experiments with wheat and rice Variation in phosphorus concentration produces a marked change in the growth of the plant With a higher level of phosphorus a vigorous vegetative growth is noticed and as the phosphorus concentration is reduced a decrease in tillering and height of the plant results The results show that nitrogen absorption varies with phosphorus concentration. Similar variation is also noticed in protein nitrogen. Addition of phosphorus at an advanced stage of growth of P-deficient plants increased the absorption and utilization of nitrogen.

It thus appears that nitrogen added to the soil either in the form of manure or by the nitrogen fixing micro-organism is not utilized to the full extent by the rice plant unless sufficient quantity of phosphorus is present in the soil

The effect of day length on nitrogen nutrition of rice plants was demonstrated by Sircar and De (1947) The following results of their work (Table I) will show that nitrogen metabolism of rice plants is greatly influenced by the application of a photoperiod of 10 hours in the seed bed and these effects are noticed throughout the life history of the plant.

TABLE I

Nitrogen analysis (% of dry weight)

		Total-N	Protein-N
Seedlings on the date of transplantation	Short day of 10 hrs.	2 01	0·14
	Control.	1 93	0·74
	% changes	+ 4 0	−81·5
7th leaf . ..	Short day of 10 hrs	2·43	1·88
	Control	2·14	1·58
	% changes	+13·5	+19 4
9th leaf . ..	Short day of 10 hrs	1·57	1·26
	Control	1·02	0·71
	% changes	+54	+78·2
Flag leaf . ..	Short day of 10 hrs.	1·91	1 54
	Control.	1·71	1 41
	% changes	+11·6	+ 8·4

Absorption of nitrogen is greatly increased in these plants and nitrogen absorbed is metabolized to protein. These results show that the effective photoperiod is of considerable importance in the nutrition of nitrogen.

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Notes and News

SNOW SURVEY IN THE HIMALAYAS

SPEAKING at a meeting of the Royal Asiatic Society of Bengal, on the 20th May, last, Dr J E Church, President of the International Commission of snows and glaciers,—who was invited by the Government of India to lay out a Snow Survey System in the Himalayas,—related his experience of the four expeditions he had already carried out during March and April last in Sikkim and Nepal, *i e*, in the catchment areas of the Tista and Kosi Dr Church revealed that this expedition had proved the presence of abundant snow water along the heights of the Himalayas up to an elevation of about 10,000 ft a. s. l Streams with catchment areas below this height depended almost wholly on rains.

Introducing the Speaker, Prof M N. Saha said that the National Government of India is contemplating far reaching schemes for development of Indian rivers on multipurpose basis. This requires conservation of the enormous water resources of India and its efficient utilization for the purposes of flood prevention, irrigation, navigation and power generation. Eighty per cent of the rains in India are contributed by the monsoons during the months from May to September, leaving the rest of the year almost dry. The rivers that maintain their flow during this period are mainly fed from the melting of the snows, which thus play an important function in the economy of the rivers. Any scheme of storages—as has been envisaged for the Kosi and the Tista must take into consideration the quota of runoff derived from the snows. The snows in the heights of the Himalayas are also found to have a considerable influence on the onset of the monsoons and the quantity of rains available from them. The snows, therefore, need careful investigation so that their role in the hydrometeorology of the country can be thoroughly understood and the knowledge utilized.

Fortunately, the science of cryology (snow investigations) has made considerable progress in the States under the pioneering work of Dr J. E. Church, who has originated a percentage forecast system by which the runoff of streams can be predetermined directly from the snow accumulations at lower elevations His methods are now utilized in making calculations before hand of runoffs for such streams as the Colorado and the Columbia on which are found the largest dams and reservoirs in U S A

The Geophysical Committee of the Government of India, which was entrusted with the task of organizing schemes of hydrometeorological survey in India, invited Dr Church to organize snow survey in the Himalayas so that annual forecasts could be made, as in the U.S A, of the total amount of water available during the dry season The Snow Survey party led by Dr Church included hydrographers, geologists, geographers, botanists and forest officers The Snow Survey of which the beginning has thus been made is expected to become a permanent feature of the scientific activities of the Government of India.

THE INDIAN COTTON GROWING REVIEW

THE Indian Central Cotton Committee has undertaken the publication of this quarterly journal, dealing with its activities and giving useful statistical and other information about Indian cotton in simple language, to the public in general, cotton growers and the trade. The first number of this periodical which we are in receipt of contain original notes and articles on cotton, and not necessarily confined to the work carried out under the schemes of the committee.

In the first article entitled 'Cotton Growing in India', the author (D. N. Mehta) says that the cotton

industry in this country is capable of great expansion not by sowing more land to cotton but by getting higher yield per acre By improvements in cultivation, the use of fertilizers, and especially, by the use of improved implements and machinery, it is possible to enhance the yield per acre of the land. Unless production is increased, India will be compelled to import foreign raw materials to enable the running of her mills The mill consumption of foreign cotton during the past year amounted to 593,000 bales, while the present estimated average production of Indian cotton over 1" in staple, being less than 400,000 bales, is not sufficient to meet the needs of Indian mill industry.

The future policy as regards production should be to grow enough cotton to meet both internal and external demand. India has a virtual monopoly of certain short staples like Punjab desi, Sind desi, Comillas, C. P Comras, etc , which command a good export market

In another article entitled 'Cotton prospects of Bengal', the writers have referred to the fame of Dacca *muslin*, spun from a type of cotton with short staple grown in the district of Dacca, Bengal But no attempt has so far been made to re-discover this Dacca variety of Bengal cotton, which has now disappeared. Attempts are however being made to extend cultivation and production of long staple cotton in Bengal to attain self-sufficiency for at least a good percentage of her people

There are three more articles on the review of work done on cotton in the United Provinces, Mysore, and Hyderabad.

We have no doubt that this new venture by the Indian Central Cotton Committee will be a success with the co-operation of all those connected with Indian cotton. India is still running short of her textile requirements and all efforts to remove the shortage should receive the best attention of the Government and the people.

BUREAU OF MINES

THE Government of India have under consideration the question of formulating a mineral policy for India. The matter was discussed at a conference of Provincial and States representatives and prominent non-officials at New Delhi, on the 10th and 13th January last. The need for legislation for the control and regulation of mining on the one hand and positive guidance and supervision of mineral exploitation on the other was emphasized by Mr C. H. Bhabha, Member for Works, Mines and Power, while presiding over the National Mineral Policy Conference.

The Government of India now propose to follow up these discussions by the establishment of a Bureau of Mines—an administrative organization, to standardize conditions of mineral development in India and also to exercise central control over the exploitation of the country's mineral assets.

The scope of this central organization will include powers to frame rules regarding terms and conditions of leases, application of improved mining methods to ensure conservation of mineral assets, control over exports, collection and compilation of statistical returns, encouragement of domestic utilization of ores and minerals, and prosecution of research on mining and fuel.

A well-organized laboratory with the latest and most up-to-date equipment will be attached to this bureau for fundamental and applied research in mineral development, and for the assay of minerals and testing of samples.

The Government of India further propose to expand the Geological Survey of India and to follow up the recommendations of the Geological Education Committee (consisting of Dr P Parija, Vice-Chancellor, Utkal University, Mr D N. Wadia, Mineral Adviser, Planning and Development Department, and Dr W. D. West, Director, Geological Survey of India) The Committee was asked to suggest (1) steps for the improvement of geological training in India , (2) what financial assistance should be given by the Government of India to universities to effect the improvements ; and (3) to make specific recommendations as to the more important centres of geological education

To give effect to the policy of nationalization, Provinces and States would be asked to evolve a formula for the assessment of compensation and to communicate their proposals to the Central Government with a view to the formulation of an All-India policy regarding the acquisition of mineral rights This will necessitate the revision of Central Mining Concession Rules (1939) and also the drafting of new rules for petroleum and petroleum products. The question of control over key minerals will be further explored, in advance of the formation of the Bureau of Mines.

CENTRAL COLLEGE OF AGRICULTURE

THE Central Government have leased the Anand Parbat Estate near Karol Bagh, Delhi for the location of a College of Agriculture to provide facilities for training in scientific agriculture up to the B.Sc. degree standard, to students from Indian States, Centrally Administered Areas and those Provinces which do not have agricultural colleges, with a view to preparing them for promoting modern agriculture and to train students for undertaking research in agricultural problems.

The College will open in July 1947 and will be affiliated to the Delhi University. Admissions to the first year class will commence after the announcement of the Matriculation Examination results

Rai Bahadur J C Luthra, Principal, Punjab Agricultural College and Research Institute, Lyallpur, has been appointed Principal of the College Information regarding admission and the courses of study may be obtained from the Principal

BETATRON DEVELOPMENT IN EUROPE

THANKS to the powerful publicity of the U S Scientific press, the Betatron is now generally known to be an American development. It is true the U S scientists led by Kerst and others have played a very significant part in the development, and the present perfection, of the induction accelerator, but notable contributions, unfortunately less publicized, have at the same time been made by the continental workers, particularly by the German scientists In the leading article in the *Journal of Applied Physics*, January, 1947, Herman F Kaiser of the U.S Naval Research Laboratory has given an account of the recent development of induction accelerator in Europe It appears from Mr Kaiser's account that the German scientists not only made similar progress in this new technique of high voltage X-ray generation, but introduced many interesting and novel features leading to better and much steadier performance

In Europe, Rolf Wideroe appears to have first worked out and developed the idea of induction accelerator in its present form in his dissertation for the degree of doctorate in 1927. It is, however, known that Biet and Tuve were also engaged in similar problem at the Carnegie Institute in Washington at about the same time The work of Wideroe greatly interested another German worker Shinpeck who further extended and developed the ideas of Dr Wideroe and took a patent in 1937. In 1935-36, Shinpeck successfully constructed a small induction accelerator but did not publish his results until after 1943. Wideroe and Shinpeck were mainly responsible for all the betatron development in Germany.

According to Mr Kaiser, the betatron development was carried out by three separate groups, *e.g*, the Megavolt Versuchsanslalt (MVA) or Megavolt Research Association, the Siemens Reiniger and the A.E.C. firms. Under the guidance of Dr Wideroe, the MVA undertook the construction in 1944 of a 15 million volt accelerator and subsequently built 30- and 200-Mev betatrons. The design of the 200-Mev betatron was greatly interfered with by the war and was later handed over to the Brown-Boveri firm in Heidelberg. The Siemen-Reiniger firms also constructed a 6 million volt betatron operating at 550 cycles, which was based on the work of Dr Shinpeck, and was one of the most successful induction accelerators developed in Germany. It has a good output of radiation and operates with almost unbelievable steady output. In this betatron inside electron injection was employed and further the unit could be adopted to various arbitrary injection and experiments, which was claimed to be one of the most interesting features of the apparatus.

The 15-Mev betatron developed by Wideroe and his group at the MVA also worked very successfully. The X-ray output of this unit varied over a wide range from 1 Kg of radium equivalent to 30 grams. Wideroe's betation differed slightly in design from that of Kerst's in that saturating guide poles were used In Kerst's design, guide fields were produced on the same pole unit carrying the accelerating flux. This modification is reported to have introduced some new design possibilities absent in the original American model and was responsible for a slightly more efficient use of iron

Mention has already been made of a 200-Mev betatron designed by the MVA, under the supervision of Dr Wideroe This unit presents many interesting features and has introduced considerable economy in the use of iron. "An interesting comparison may be made in the way of weight," writes Mr Kaiser, "between this design which is to weigh about 40 tons for a 200-Mev rating and the 130 tons of the American General Electric Company 100-Mev machine In this 200-Mev design certain improvements, is such as the use of permagnetization, are considered"

U. S. ATOMIC RESEARCH LABORATORY

THE Atomic Energy Commission, it is announced, has decided to construct a new Atomic Research Laboratory, to be called the Knolls Atomic Power Laboratory, in Niskaynna near Schweetady. The General Electric Company has undertaken to supervise the construction of the Laboratory which is expected to be complete by the middle of 1948.

The plan of the Knolls Atomic Power Laboratory envisages the construction of a series of buildings, in one of which an experimental pile will be located. The pile, it is expected, will form the firebox and boiler of future atomic power plants. Laboratories for Chemistry, Chemical Engineering and Metallurgy, will be housed in separate buildings. The Laboratory is further proposed to be equipped with a 3,500,000-volt Van de Graff generator for atom smashing studies.

Dr C. C. Suits, Vice-President of the General Electric Company, will direct the Atomic Power Laboratory. Its main purpose would be to conduct research in all phases of atomic power development

in addition to research on specific problems in connection with the operation of the Hanford Engineering Works, Washington, now operated by the General Electric's Chemical Department. A number of scientists, including physicists, metallurgists, chemists and chemical engineers, have already been recruited for the project.

ATOMIC RESEARCH IN GERMANY

IN an interview recently reported in the *Times*, Professor Heisenberg referred to the progress of atomic research in Germany during the war Professor Heisenberg supervised the whole of atomic research project in Germany and stated that up till June 1942 they were on the same level of progress as the Americans On June 6, the German atomic experts working on the project reported to the armament minister, Spur, the possibility of manufacturing atomic explosives either by the separation of uranium isotopes or by building a uranium pile and indicated that about two years or longer would be necessary before plutonium could be successfully extracted This was a terribly long time for Hitler who, as Professor Heisenberg stated, was not prepared to consider any military measure that would take more than six months.

The industrial capacity of Germany being at that time very seriously strained, the separation of isotopes could not be undertaken on a scale required for such a project, and the German experts went ahead with the uranium pile A uranium pile using two tons of uranium, two tons of heavy water and ten tons of graphite was built at Haigerloch

Professor Heisenberg also referred to the efforts of the Soviet Government to requisition the services of German atomic experts The Soviet Government offered 6,000 roubles a month to any such expert agreeing to do atomic research for the Government Professor Heisenberg himself received a similar offer and was promised, in addition to his pay, 50 pounds of fresh meat a month, 3,500 calories of food a day for each of his six children and a comfortable house, but he refused Three German scientists, Professor Gustav Hertz, Dr Robert Doepel and Dr Ludwig Bevilogua, are already helping the Soviet Government on atomic research.

SCIENTIFIC EXPERIMENTS IN BIG BEN

ACCORDING to an information released from the Department of Scientific and Industrial Research, the Houses of Parliament are being used for scientific investigations by the Department Instruments for recording the sulphur dioxide in the air have been set up near the top of the Big Tower and on the Speaker's Green.

Sulphur dioxide is one of the causes of decay in building stone, including the magnesium limestone of which the Houses of Parliament are built. Most of it is produced in the combustion of coal. The main object of the measurements being made is to compare the sulphur dioxide concentration at ground level with that at a considerable height above the ground. The vertical distance between the instruments is 238 feet.

The instrument on the Speaker's Green is at the top of the landing steps by Westminster Bridge. The apparatus is contained in a small louvred box on top of a green post five feet high. The other instrument is less noticeable, being on a small platform above Big Ben The research is part of the work on Atmospheric Pollution being carried out by the Fuel Research Station, D.S I R

ANNOUNCEMENTS

WE have much pleasure in announcing that Mr S N Sen, Assistant Editor of "Science and Culture" and Professor of Physics, Scottish Church College, Calcutta, has been appointed Registrar of the Indian Association for the Cultivation of Science Mr Sen had a brilliant academic career at the Calcutta University from which he took his Master's Degree in Pure Physics and topped the list of successful candidates. As a science writer, he has already made a name and is known to our readers through his diverse writings and wide interest in all branches of science His recent popular book on Atomic Energy (in Bengali) is widely appreciated We wish him success in his new sphere of activity.

THE Institute of Chemical Engineers (London) have awarded the Junior Moulton Medal and Prize for 1946 to Dr Homi E Eduljee, Ph.D., D.I.C., A R I C, for his paper "Entertainment and Efficiency in Distillation Columns", being the best paper of the year. Dr Eduljee is the first Indian recipient of this honour

WE have much pleasure in recording our grateful thanks to the Rockefeller Foundation for a donation of Rs. 1,000/- and to the Government of India for a donation of Rs 750/- to the Indian Science News Association for 1946-47. Both these donations were disbursed through the National Institute of Sciences of India

The National Institute of Sciences of India has gratefully accepted the gift of 44 books on scientific subjects and 67 copies of journals, published by the U.S.S.R. Academy of Sciences, following the visit of a delegation of scientists to the last session of the Indian Science Congress held at Delhi, in January last.

SCIENCE IN INDUSTRY

NEW METHOD OF PRODUCING A POSITIVE PHOTOGRAPHIC PRINT IN A MINUTE

It is well known that in conventional photography the negative is developed, fixed, dried, put in contact with bromide paper and exposed to light to produce a positive print The paper is then developed, fixed and dried Thus the process of obtaining a finished positive print is a slow one In an article published in the February 1947 issue of the *Journal of the Optical Society of America*, Edwin H Land has described a new method of producing a finished positive in a minute He has tried several methods and one of them has been found to be highly satisfactory. In this method the film is first exposed to light to produce the negative, one end of the film

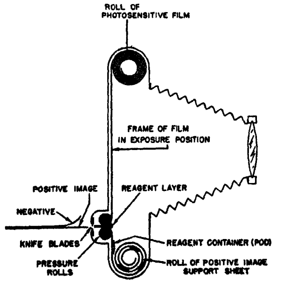

FIG. 1 Schematic diagram of camera producing one-step positive prints.

being held between two rollers placed inside the camera as shown in figure 1. One end of a strip of paper of the same width as that of the negative also passes through the rollers and a layer of a mixture of some chemicals is introduced between the two strips. As the strips are drawn out through the rollers, owing to the pressure, they are bonded together with the layer of mixture of chemicals lying between them. The outer surfaces of the sheets are opaque to actinic light to protect the negative from being fogged.

When the two sheets are bonded together the chemicals in the layer lying between them develop the exposed grains and dissolve the unexposed grains of the negative. The dissolved grains are then precipitated by the chemicals as metallic silver in a layer adjacent to the negative either in the thin layer of the reagent or on the surface of the positive sheet. Since the precipitated metallic silver is black and appears only in those regions of the reagent layer which are adjacent to the exposed regions of the negative the black regions of the positive correspond to shadows on the negative The regions of the positive in which no such black silver is precipitated appear as white Hence the positive produced by this process looks exactly like an ordinary positive print The positive and negative bonded together are completely drawn out through the rollers and then the former is peeled from the latter. Both are essentially dry at this time

The chemicals used in this method are hydroquinone, sodium hydroxide, sodium thiosulphate and sodium sulphite all mixed together and dissolved in a solution of high molecular-weight material such as carboxymethyl cellulose or hydroxyethyl cellulose The mixture is highly viscous It is put in narrow pods of length equal to the width of the positive sheet, the pods lying with their length parallel to the width of the positive sheet The viscosity of the mixture helps it to spread uniformly on the positive sheet as the two sheets are drawn through the rollers. The mixture also forms a protective layer on the positive. The whole process works satisfactorily in a temperature range of 30°F to 100°F and it is completed in a minute.

In conventional photography the contrast in the positive is manipulated by choosing bromide paper of suitable quality. In the new method the positive obtained with a particular exposure is examined and if found defective, a second negative is obtained with another suitable exposure so that the defect in the positive produced from this negative by the new process is removed. The resolving power of the process ranges from 10 lines per mm. to 30 lines per mm.

S. C. S.

BAUXITE IN AUSTRALIA

APPREHENSIVE of a shortage of bauxite in Australia, the Government of Australia and Tasmania appointed sometime ago the Australian Aluminium Production Commission which has just issued its first

report (*The Chemical Age*, April 5, 1947). Extensive prospecting and research carried out by the Commission have now revealed further new deposits of bauxite. Thus bauxite resources of Tasmania were previously estimated at about 800,000 tons, of which 600,000 were readily available and were considered to be of suitable grade But the discovery of 80,000 tons of one south-east of Launceston and indication of a further 120,000 tons now make the total reserve exceed one million ton.

Among the larger bauxite beds chartered in Australia are New South Wales, 18,250,000 tons of 38 per cent AL_2O_3 and 5 per cent SiO_2, Boolarra-Mirboo (75 miles from Melbourne), 735,000 tons of 51.3 per cent AL_2O_3 and 7·6 per cent SiO_2 In Queensland, where little is known of bauxite resources, the State Government has embarked upon geological surveys, and the Commission is hopeful that these may result in the location of higher grade ore than has previously been found in Australia.

The large lateritic bauxite resources of Western Australia are too high in silica to compete with the supplies available in Tasmania and Victoria. Investigations into the possibility of improving the grade by the removal of free silica, thus bringing it into the range of economic usage, are to be carried out.

Samples of Victorian and Tasmanian bauxite were already analyzed and tested in U.S.A., and favourable results were reported The Commission is generally of opinion that the continent now stands a fair chance of being self-sufficient with regard to the supply of this important and strategic mineral. At present the question of establishment of a large-scale aluminium industry and the various technological problems connected with such industry are being studied.

STORAGE OF POTATOES

H C CHOUDHURI,

SPECIAL OFFICER (POTATOES), DEPARTMENT OF AGRICULTURE, BENGAL

THERE is no agricultural crop plant which possesses so wide an appeal throughout the world as the potato and it is probably the most widely grown of all the vegetables. Interest in the crop ranges from the specialist growers to any amateur who has few "*Cottahs*" of land to cultivate The reasons for such a popularity are three fold. Firstly, the potato yields several times (about 15 to 25 times) its own weight of seeds, and secondly, it can withstand a long period of storage provided it is kept under suitable conditions, and thirdly it is more profitable than any other crop

In parts of the country where the potatoes are produced on a commercial scale the problem of storage is important, as it is practically impossible as well as economically undesirable to attempt to market the entire crop after it is harvested To ensure uniform supply throughout the year storage must be provided at proper place. Types of storage places employed vary with the quality of potatoes to be stored and the length of the storage period.

The climatic condition of this country is such that the potatoes are subject to rottage and deterrioration during prolonged period of storage. It has been noted that during this period the fungal, bacterial and insect-infection which usually take their root just after harvest manifest in storage causing serious damage to the stored crop. Competent authorities have estimated that a fair proportion of our crop is lost due to rottage, dryage and deterioration

INDIGENOUS METHOD OF STORING POTATOES

The indigenous methods of storing potatoes although vary in some minute details from one part of the country to the other, the broad principles are the same all over. The potatoes intended to be kept for a period of 5 to 6 months are usually stored in a proper godown Before it is done so, dry river sand is spread on the floor or on shelves (*machans*), if there be any, to a thickness of say ½ inch, and on the thin layer of sand the potato tubers are spread to a depth of ¾ inches. The depth of the potato tubers depending entirely on the variety stored and on the prevailing climatic condition Delicate varieties are stored to a depth of say 4 inches whereas hardier varieties of Nainital type are often stored to a depth of about 1 ft.

In certain parts onion or garlic bulbs are spread on potato tubers to the extent of 1 and ½ seer per maund respectively to protect tubers against insect pests during storage.

The late maincrop usually harvested in February to March and in some places as late as first fortnight of April are to be stored from mid-March to December until the first early is on the market. The period

from March December is most difficult period of the year when both temperature and humidity are usually high and the potatoes are liable to serious damage unless carefully stored under suitable conditions The ordinary method of storage can hardly give suit

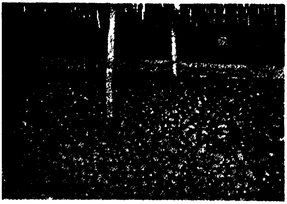

FIG 1 Potatoes stored on bamboo shelves Note that the potatoes are spread over to a depth of about 4

able temperature humidity and free air circulation to preserve the tubers It has been experienced that during the period of storage insect pests and fungus diseases take a heavy toll of the stored potatoes with the result that losses in storage may amount to 25 50 per cent (Fig 1)

Essential Conditions for Storing Potatoes

The storage house should be in a well drained location to be damp proof Day light should be excluded as it causes greening which injures quality of table stock It is not advisable to store potatoes (of hardier varieties) on bins more than 6″ to 8 deep A continuous space for air circulation should be provided between the bins and outside walls and between the bottom of the bins and main floor Provision should be made for entrance of fresh air Ventilators must be provided for cooling the store house when the weather conditions require it The manipulation of ventilators is highly important and require close attention

If ventilation is restricted during the first two or three weeks of storage (after harvest) so as to hold the potatoes at about 55°—60°F and in high atmosphere humidity that prevails in a bin of freshly dug potatoes, the normal shrinkage can be reduced to about 20 per cent Further, potatoes receiving this preliminary treatment seem to retain better keeping quality than if storage temperature is lowered immediately A low temperature at the beginning of the storage is not necessary because the tubers are then in a state of dormancy. After this curing period temperature may be lowered below 36°F

Storage of Potatoes in the Hills

The storage of potatoes in the hill districts can be carried out successfully without the aid of the cold storage provided the potatoes are of high quality

In the district of Darjeeling it has been experienced that potatoes can be stored in ordinary godown on the floor to a depth of 1′ 2′ The potatoes are turned over once in a fortnight and the diseased potatoes are sorted out It has been estimated that loss of potatoes due to rottage never exceeds more than 10 per cent during the storage period for six months

Cold Storage

It is too superficial to emphasize here that the indigenous method of storing potatoes in the plains of India in summer months is far from satisfactory The main problem is to protect the tubers from high temperature in summer months A thorough and careful examination of the situation suggests that the only solution of the problem lies in storing potatoes at low temperature

Potato tubers freeze at 29°F Experience have shown that the best storage temperature for ware potatoes is 0°F Potatoes stored at a temperature slightly higher than 40°F have better cooking quality specially for making chips because they contain less sugar than those stored at lower temperature But in the high temperature range however sprouting occur in short time which injures the quality of table stock Potatoes stored at 40°F can be improved of their cooking quality by holding at 60°—70°F for

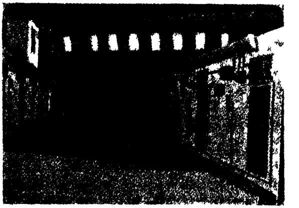

FIG 2 Cold storage of potatoes Note the heavy doors of the cold chambers

about two weeks before they are used on the table This permit some of the sweetness to disappear The relative humidity inside the store should be kept at 85—90 per cent

It has been noted that the best storage temperature for seed potatoes is 36°F when stored for a period of 5-6 months. At this temperature the relative humidity inside the store is kept at 75-80 per cent.

There is absolutely no loss due to insect pests and there is considerable reduction in the loss due to fungus when the potatoes are stored in cold chambers. The loss due to dryage, shrinkage and rottage is very small and never exceeds 10 per cent.

In designing a cold storage a minimum of 6 cft space per maund of potatoes to be stored must be allowed for, since a smaller space than this will result in serious trouble *viz.*, (*i*) difficulty in loading and unloading, (*ii*) difficulty in providing adequate cold air circulation which is essential for proper preservation of tubers.

The cold chambers should be in different section each independent of other in so far as cooling coils are concerned and there must be suitable precooling chambers, so located that the cooled chambers are easily accessible from it. This is very important as the precooling chambers play a very important part in both at loading and unloading times.

Each cold chamber should be provided with suitable bins all along walls of the cold chambers and also in the centre of the room. The potatoes should be spread out at suitable depth in the bins so as to provide free circulation of cold air (Fig. 2).

CONCLUSION

It is quite evident from the foregoing paragraphs that the percentage of loss can hardly be reduced under ordinary methods of storage and the only satisfactory method lies in storing potatoes at low temperature. The loss to the extent of 25-50 per cent of our potato crop due to defective method of storing is a serious loss to our national economy. It may also be emphasized that there is no use in trying to improve the crop without attempting to improve the methods of storage since improved crop can not be allowed to rot by storing them under ordinary methods. Although this has hardly been realized yet a time will come when it will not only be possible for us to store all our seed potatoes but even the ware potatoes.

MEDICINE AND PUBLIC HEALTH

SYNTHETIC PENICILLIN

THE announcement that American research workers have recently isolated a specimen of synthetic penicillin has led to report that synthetic penicillin will very shortly be cheaply and plentifully available. Such reports are, however, based on a misunderstanding of the nature of the synthesis achieved. The work has been done by Dr Vincent du Vigneaud and his research team at the Cornell University Medical School, New York, and is described in *Science* (1946, Vol. 104, pp. 431-33). They found that the product of reaction between two decomposition products of penicillin—d-penicillamine and 2 - benzyl - 4 - methoxymethylene - 5(4) - oxazolone- possessed slight antibacterial activity. Assay showed, however, that the yield of penicillin was less than 0·1 per cent. A similar result was recorded by Oxford workers in 1942, they demonstrated that the activity of the product was due to penicillin by inactivating it with the highly selective enzyme, penicillinase. In view of the very low yield, however, the reaction was not further investigated at Oxford.

Starting with this very impure reaction product, du Vigneaud and his colleagues obtained, by a laborious extraction process, about 8 milligrammes of crystalline synthetic penicillin G. The course of the reaction and purification was followed by replacing some of the ordinary sulphur atoms in the penicillamine by a radioactive sulphur isotope which could be detected by Geiger counters. The work is of considerable theoretical interest and a fine example of skilful chemical research, but it is of no commercial importance because the starting materials themselves are difficult and costly to synthesize, the yield is tiny and the purification process very time-consuming. Difficult though it is, however, the method may be valuable for preparing, for experimental purposes, varieties of penicillin other than those known to be produced by the mould. (*Discovery*, February, 1947).

A FIVE-YEAR PLAN ON MEDICAL RESEARCH

A COMPREHENSIVE five-year plan of medical research and its applications was adopted in preliminary form by the Academy of Medical Sciences of the U.S.S.R. early in September 1946 and was formally adopted in November last. This plan,

covering 200 mimeographed pages, will appear, in the *American Review of Soviet Medicine*. The areas of research covered are thus listed in the Table of Contents:

I *Main Problems of Public Health in the Post-war Period.*—Scientific principles of Soviet public health protection, Medicosanitary consequences of the war and measures for overcoming them, hygienic standards and sanitation of external environment, protection of the health of mother and infant, child health protection; protection of the health of industrial workers; problems of nutrition

II *Medical Problems arising from War Traumas.*—Restoration of functions after war traumas, clinical and pathophysiologic study of traumas of the nervous system and their restorative therapy; biology of infected wounds, traumatic shock, the problems of pain

III *Problems of Infection in Theory and Practice.*—Infection and immunity, epidemiology and pathology of infection, malaria, helminthiasis and other problems of medical parasitology, ultra-viruses and ultravirus diseases; tuberculosis, problems of scarlatina in child health protection; the problem of sepsis, etiotropic therapy of infectious diseases

IV. *Urgent Problems of Clinical Medicine.*—The problem of malignant growths, hypertonia, gastric and intestinal ulcers; problems of modern hematology and blood transfusion.

V. *Physiologic Regulation and Means of Actively Influencing it*—Reactivity of the organism, correlative processes in the organism; regulation of the composition and properties of the internal medium of the organism; pharmacological regulation of functions; the influence of physical factors on the human organism, capacity for work, fatigue and rest

VI *Physiology and Pathology of Nervous Activity*—Factors of integration in the nervous system, the higher nervous activity, psychoses (pathogenesis and therapy)

VII. *Certain Problems of Theoretical Medicine*—General physiology and pathology of the cell; growth and development of the normal pathological organism; metabolism and energy, the physiology of digestion, history of medicine

The secretary of the Academy states that the proposals incorporated in this plan originated with the staffs of the 25 component institutes of the Academy They were then subject to discussion between the presidium of the Academy and the component institutes The plan, as finally agreed upon, was adopted by the Academy and returned to the institutes as a recommended but not obligatory programme. The emphasis of the plan on fundamental theoretical problems is noteworthy (*Science*, March 21, 1947)

INVESTIGATIONS ON SOYA BEAN MILK AND RELATED PRODUCTS

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OUR studies on the above subject were started, about two years ago, with the background of the earlier work done under the auspices of the Soya-bean Sub-Committe of the Indian Research Fund Association That committee conducted its researches, mostly, on the nutritive value of the whole bean The committee concluded that the bean, used in that form, is not superior to the average Indian pulses. We also came to the same conclusion regarding the whole bean as we found that the biological value of the protein in the *dhal* was only about 55. In the human body the utilisation is presumably much less. Many consumers have reported that continued use of soya *dhal* leads to digestive troubles

There is remarkable improvement when the bean is suitably processed and converted into the milk. It is in this form that the bean is largely utilised in China, Japan and other countries. After extensive trials, we found the following to be important steps for improving the taste, flavour and nutritive value. (1) steeping and incipient germination; (2) extraction of the kernel with dilute sodium bicarbonate to remove the colouring matter and bitter principle; (3) pasting to very fine condition; (4) adjustment of reaction and vigorous boiling, (5) incorporation of calcium in some suitable form; and (6) addition of salt and a small percentage of cane-sugar or invert sugar.

ANIMAL EXPERIMENTS

The protein of the milk thus prepared has a slightly higher digestibility (92 per cent) than that of good dairy cow's milk (88 per cent). The biological value (80 per cent) is not much lower than that of cow's milk protein (84 per cent). The vitamin B

complexes of both the milks have been found to be of the same order The biological value of the protein exceeds that of cow's milk both on extended germination and on supplementing the milk with calcium. The only element in which the milk is naturally deficient is calcium and we add this as a part of our preparation. The milk thus prepared has a supplementary value corresponding to about 80 per cent of that of cow's milk when added to South Indian diet This is very interesting because, when used as a whole, the bean has not been found to have any supplementary value.

Human Feeding Experiments

Our next object was to demonstrate the value of the milk by actual human feeding experiments To facilitate this, we had to standardise the conditions for the large-scale production of milk.

We had quite an uphill task getting the supply of beans from North India and setting up the equipment Thanks to the kind interest of Sir Philip Gaisford, the Resident in Mysore, and support from the Food Department, we were able to go forward We are now making about 600 lbs. of milk per day Even with our limited equipment, we could produce thrice this quantity, but the supply of the bean is still a limiting factor The milk is now being used, both as such and after sour curdling, for human feeding experiments

Experiments in welfare centres.—About 120 children ranging in age from a few months to about six years are under experiment The trials have been going on for the past four months Soya-milk is being compared, in the same age groups, with cow's milk. The results already obtained suggest that babies do slightly better on soya milk than on cow's milk. The older children respond nearly equally well to both the milks The experiments are still in progress.

Experiments in children's hospitals.—This experiment has been recently started, with the kind interest and co-operation of Dr (Miss) Albuquerque in the local children's hospitals. This experiment promises to be of much value as all the children will be under strict medical observation. A section of the children will also be on cow's milk as control The trials are still in progress.

Feeding primary school children.—This experiment has been rendered possible by the keen interest and enthusiasm of Mr P M. Jayaranjan, the Collector of C. & M. Station and his staff. The programme is to provide 5,000 school children per day with a midday meal of curd (4 oz.) and rice (8 oz.-cooked). We are now providing curd for only about one-third of the total number, while the rest receive curd prepared out of separated milk. The latter provides a useful control. Soya curd is prepared in the same way as cow's milk curd and has practically the same taste and flavour The initial selection of the proportions was made by a panel which included Mr W. H. Kirby, the Rationing Adviser to the Government of India. The panel was in favour of using soya curd exclusively for the feeding, but the beans being in short supply, we could provide only 400 lbs per day. It is hoped that the supply position will soon improve

The school feeding experiments have been in progress since last June Periodic health inspections are being made on a representative section of the children. It is hoped to have a bigger organisation at a later date.

General Observations

One significant finding that has arisen from our feeding trials and consumer tests is that the milk and curd are very easily digested Babies require feeding almost twice as frequently as on cow's milk, while adults report that drinking soya milk is almost like that of water

Infants and persons with weak digestions generally respond better to soya milk than to cow's milk Soya milk contains a pre-cooked protein and does not form any hard curd on contact with stomach juice. This may account for the facility in digestion The milk contains practically no starch and very little soluble carbohydrate. It will make an ideal food for the diabetic if no extra sugar is added. It will also make a good invalid food

The Flavour of Pure Soya Milk

A general observation made by many who have sampled the milk is that it has a nutty flavour and that they would like the usual milk flavour incorporated in it. We are now conducting some experiments with that object A simpler way of approach and one which we have tried out in household practice is to add 15-20 per cent of the volume of cow or buffalo milk and to heat the mixture to boil. This imports the desired favour. The mixture can be used for practically all purpose in place of cow's milk.

Supply of Bean, the bottleneck in Extended Production

There is already a good deal of public interest in the production of soya milk and related products. Many cities and commercial organisations have already expressed a desire to start large-scale feeding trials. The chief 'bottleneck' at the

present time is the availability of the bean at a reasonable price. Every province in India can grow soya bean, but at the present time, there is very little production. Some area is now being brought under the crop and it is hoped that, at least during the present season, sufficient quantity of beans will be grown so as to facilitate trials at a larger number of centres The co-operation of the Government Agricultural Departments is badly needed.

The Cost of Soya Milk

The price of soya milk is determined, to a large extent, by that of the bean We have so far been able to purchase the bean at between 2½ and 3 annas per lb., but transport charges from North India have been very heavy A fair price for the bean produced locally will be about two annas per pound, even allowing for the general rise in the cost of food materials It is a short duration crop (3-4 months) and, with proper manuring, the yield should be at least 800 lbs per acre It is known that once the crop is established, the yield will improve One pound of bean yields between 5 and 6 lbs of milk Under normal conditions, it should be possible to distribute the milk. at a price not exceeding 1½ annas per pound.

Equipment for Large-scale Production of Soya Milk

Large-scale production of soya milk is comparatively easy and requires no elaborate equipment The initial soaking of the bean can be done in shallow vats or other types of containers It can even be done on a cement floor with some suitable bund to hold the water The removal of the skin can be done with a mechanical pulper We are using a modified coffee pulper but it is not so efficient as we would like. The skin and the kernel come out together and a lot of water has to be used for the separation. If the germinated bean is first dried, the skin is more easily separated. A flour mill, suitably adjusted, is quite efficient in effecting the separation The kernel, if properly dried, stands storage in the same way as *tur* dhal (*Cajanus indicus*). If the dried kernel is to be used for making the milk, it has to be soaked again, for 4-5 hours, prior to commencement of operations. The soaked kernels is next treated in a steam-jacketed pan to remove colouring matter and bitter principle. Water is first run in and baking soda ($NaHCO_3$) to correspond to 0·04 per cent in the extracting water is added. The contents of the pan are then heated to about 70°C. and maintained at that temperature for ten minutes. The heating is then stopped and the extracting fluid is decanted out as much as possible. Cold water is then run in and after proper admixture, it is again drained out. This operation is repeated a few times until the kernel is clean and has an almost white colour and a nutty taste. The kernel is then transferred to a suitable mechanical grinder We have found the stone edge-runner to be quite useful This does not however give a fine enough paste, so, we follow up with re-pasting in a granite triple roller mill This gives a very fine paste The paste is then transferred to the boiling pan and water added to correspond to slightly over three times that of the paste (This will correspond to about six times the original volume as the bean absorbs its volume of water during soaking) A calculated quantity of sodium bicarbonate or other milk alkali is added so as to neutralise any residual acid in the kernel and to regulate the final reaction of the milk The suspension is raised to boil with gentle stirring. Like cow's milk, the soya milk is also apt to swell and froth vigorously, so, the initial heating should be carefully controlled Once the initial frothing subsides, the subsequent boiling is easy The milk is boiled gently for 15-20 minutes It is then allowed to cool to some extent and to settle for a few minutes and then filtered while still fairly hot This procedure eliminates the risk of a part of the cream being lost as the skinny layer on top The filtration is best done through a fine mull cloth or other type of close woven fabric It is fairly rapid. The whitish residue, still holding a good deal of milk, is transferred to separate containers The milk is then treated with calculated quantities of salt (0·1 per cent) to improve the taste. Cane-sugar (3 per cent) is also added to raise the level of carbohydrate to that of cow's milk but this may not be always necessary as the average user usually sweetens a milk to taste The milk is then transferred to a cool place (we use a cold storage room) and kept there till it is taken out for distribution.

Calcium salts can be added either to the paste or to the finished milk. We have found that many of the calcium salts impart a peculiar taste to the milk. The flavour is also affected to some extent. We have found that addition of marble powder at the time of pasting improves both the taste and flavour

The residual paste still holds about 30 per cent of its weight of milk. The paste is rather spongy, so the milk contained in it can be separated only by application of pressure We have been using a wooden press, but a metal press made of stainless steel or other good alloy will be more efficient

Soya milk prepared in the above manner keeps quite as well as cow's milk. In the cold, the milk can be safely preserved for 48 hours or more. At the ordinary temperature it keeps for the best part of a day.

CHOICE OF VARIETY—COLOUR AND TASTE OF SOYA MILK

We have experimented with some of the varieties available in India and have found that the white and pale yellow varieties are suitable for yielding milk with the same shade of colour as cow's milk. If these varieties are used, it may not be necessary to remove the last traces of the skin The only dark variety (K 16) which we have tried, yields a milk with a slightly better flavour and taste than the other varieties It is apt however to possess a somewhat dull colour owing to the extraction of a very small amount of colour from the skin which could not be completely removed In large-scale practice, the lighter coloured varieties would be preferable.

VARIED USES OF SOYA MILK AND RELATED PRODUCTS

This aspect has been carefully studied. For different food preparations, involving any cooking, soya milk can be used in exactly the same way as cow's milk. The preparations are usually flavoured with spices, so, no difference can be noticed between the two sets of preparations. For addition to beverages like coffee and tea, the soya milk is best mixed with a small proportion of cow's milk as we are more accustomed to the flavour of cow's milk. For cocoa preparations, the soya milk can be used as such. If we can incorporate cow's milk flavour with soya milk, it can be used, freely, in the same way, as, cow's milk Precipitated soya protein can be used for different preparations in the same manner as cow's milk protein There is practically no difference in the taste and flavour of the two sets of preparations.

The most attractive product prepared out of soya milk is the sour (lactic fermented) curd. The ordinary soya milk does not sour quite readily, but we have found that addition of 1-2% invert sugar brings about very rapid souring in the same way as cow's milk. The resulting curd has the same taste and flavour as cow's milk curd, the fermentation process following practically the same course in both the cases. The curd can be used either as such or converted into butter-milk as is done over a large part of India The butter-milk is the chief dairy product required by the rich and the poor over a large part of India but there is not enough of it and most people go short. The availability of cheap butter-milk from soya-bean would therefore be a real blessing to a considerable section of the people.

SOME OUTSTANDING PROBLEMS

Further Improvement in the Flavour of the Milk.—Although our present taste for cow and buffalo milk is an acquired one, we are still accustomed to it and continue to like it. It is rather interesting to note that over a considerable part of China the people dislike the animal odour in cow's milk. It has been stated by our Chinese friends that even occasional use of cow's milk leads to digestive disorders. The nutty flavour of soya milk is pleasing to those who are familiar with it, but, to familiarise those who are using it for the first time, it would be desirable to incorporate some milk flavour. Synthetic milk flavours are attractive to begin with, but seem to undergo some change on prolonged contact with soya-milk. We have found that incorporation of barley malt at the pasting stage and scalding of the resulting milk by strong heating improve both the taste and the flavour. We are conducting further studies in this direction as the flavour is an important factor determining the popularity of the milk.

Enhancement of the Nutritive Value.—Our experiments with groundnut milk have already shown that incorporation of a small percentage of cereal protein helps to increase the biological value of the groundnut protein Soya milk protein is naturally superior to groundnut protein and will therefore respond better to supplementation Further incorporation of calcium and other essential minerals will also be helpful Supplementation with fat soluble vitamins will also improve the nutritive value. With steady improvement, it should be possible to produce a balanced milk with the same supplementary value as that of good grade cow's milk

Improvement of manufacturing methods—There is need for a good mechanical device or chemical treatment that will completely remove the skin from the germinated bean and yield a clean kernel Drying of the germinated bean and then removing the skin is a round-about method and should be avoided if possible. We require some equipment that will yield the finest paste as a single operation We are now grinding first in the edge runner and then in a roller mill There should be an automatic method of filtering the milk and at the same time pressing out the milk held in the residue. We are now doing this as two operations. There should be some simple procedure for using the residual paste, either as such or after drying, as an article of human food. We have at present no difficulty in using it as an animal food.

Organised production of the right varieties of beans.—Among the oil-bearing seeds that we have so far tried, soya-bean yields, by itself, the milk of the highest nutritive value. The pulse is unique in many respects In composition and properties it comes half way between a typical legume and an oil-seed. It has considerable potential possibilities not only as a food but also in the plastic and other industries. The Government should therefore take keener interest in the cultivation of soya-bean in all

the provinces of the country There is already some experience in growing the bean, but more information is required regarding the right variety for each area, the season for sowing, manurial and other requirements and so forth There is immediate need for at least some hundreds of tons for carrying out extended trials in different parts of the country and to popularise the use of the milk and the related products It is earnestly hoped, therefore, that both the Central Agricultural Departments and the Provincial Departments will take more active interest in the subject and set up the necessary organisations for ensuring a steady supply of the bean in different parts of the country

BOOK REVIEWS

"Methods of Mathematical Physics"—By Harold Jeffreys, M A , D Sc F R S & Bertha Swirles Jeffreys M A , Ph D Cambridge University Press, 1940 Price £3 3s net

The book on 'Methods of Mathematical Physics" by H Jeffreys and B S Jeffreys covers a comprehensive field of mathematical analysis, used in classical and modern physics The name "Methods of Mathematical Physics" recalls the famous German treatise "Methoden der Mathematischen Physik" by the celebrated German mathematicians R Courant and D Hilbert, which has been highly prized by workers in Theoretical Physics all over the world A closer scrutiny reveals, that inspite of the similarity of names, the present book differs from the earlier one both as regards its objects and contents The German treatise is written from the standpoint of a pure mathematician, dealing with the more abstract propositions of "Analysis" and "Algebra" the object being to equip the physicist with subtle and powerful mathematical methods so that he can tackle his problems properly A proper understanding of Courant and Hilbert requires a fair background of mathematical knowledge, seldom possessed by the average worker in physics The present book, on the other hand, starts, from elementary ideas and proceeds to the advanced topics by way of appropriate examples and illustrations, introducing the rigorous mathematical proofs gradually The most illuminating feature of the book is the numerous examples taken from the different branches of physics, which helps much in the clarification of the mathematical methods used As such, the book will prove extremely valuable to a beginner The authors have attempted successfully to meet the difficult task of satisfying a physicist and a mathematician, at the same time

The several chapters on analysis and theory of functions are well developed In writing these chapters, the authors seem to have a practical object in view Almost all the fundamental processes of analysis are given and the functions that are more frequently needed by the students of physics, *viz* , the Factorial, the Bessel and the Legendre functions have been treated in some details, with applications to physical problems The chapter on "Fourier Theorem' is also well developed The authors have seldom entered into the mathematical details of analytical rigour The ideas of "uniform convergence", 'Reversal of the order of limits" (*viz* , Differentiation under the sign of integration, term by term integration of a series) etc , which are often indispensible for correct applications of the mathematical theorems to the physical problems should have been developed in some details

From the standpoint of quantum mechanics, a more elaborate treatment of the theory of quadratic and hermetian forms, and an introduction to the idea of vector space, and a chapter on the "Abstract function space of Hilbert", showing the close analogy between ordinary differential, multiplicative operators and matrices, we think, will be an important addition to the book But for the omissions, the authors have succeeded in giving a good survey of the theory of matrices

Chapter IX, on "Numerical Methods" form a very interesting and useful feature of the book In this chapter, they have presented in a nut-shell, all the numerical methods that are usually needed by workers in physics for integration of complicated functions and solution of ordinary differential equations. Considering the standard of the book, the treatment of Laplace's equation may be regarded as satisfactory Probably the reader would have been very grateful if the authors treated in some details, the wave equation, the equation of heat conduction and diffusion, and the Schrödinger wave equation, dealing with the integration of these equations by the method of integral transforms (*viz* , Laplace's transform and Hankel transforms, etc.).

The introduction of a few more chapters on "Integral equations", "Theory of Groups", "Expansion of an arbitrary function in a series of other functions", etc will be warmly appreciated.

Considering the size of the book, the authors have successfully attended to a wide variety of topics, introducing the mathematicians to the demands of a physicist and the physicists to mathematical avenues

M. N. S. & S. C. D.

Acton: The Formative Years—By David Mathew Eyre & Spottiswoode, London 1946 Price 10s 6d.

Lord acton was not only a great historian, he was one of the most prominent intellectual leaders of England in the last quarter of the nineteenth century His fame as a historian has been growing steadily since his death in 1902, for later observers can see more clearly than his contemporaries the penetrating quality of some of his judgments and the unique grasp that he possessed of the essentials of European politics in his age. In him a very wide experience of political machinery was combined with an unparalleled array of historical knowledge He had a a unique appreciation of the consequences which were likely to spring from the unbridled Nationalism which dominated Europe in the last century. He was among the first to understand the evil latent in all racial theories In this respect he was much more than a mere learned historian ; he was a philosopher, but he was not isolated from the realities of life From him English intellectual life received a stamp which the lapse of half a century has not completely worn off.

The book under review is not a conventional biography of the "Life-and-Letters" variety The author himself is a distinguished historian who has contributed substantially to our understanding of British history in the seventeenth century The present work—a small volume of about 200 pages—is a study of the early years of Lord Acton who is described as "the protagonist of the Liberty of the individual against the State" "The Formative Years" of the great historian's life covers the period 1834—62 The story of these years is told in a style at once vivid and controlled, and the materials have been utilized with careful and measured scholarship. We are assured that Bishop Mathew will give us a sequel dealing with Lord Acton's later life (1862-1902) and the contribution of his maturity. Although we are told that the present volume is complete in itself, probably none of its readers will be satisfied till the portrait of Lord Acton in his maturity is available.

Perhaps the most attractive feature of the book under review is the picture of the background of Lord Acton's life—"Neapolitan, Russian, South German, French, at once rich, lavish and improbable, crossed with the old Catholic squirearchy of the West of England and set in the last serene days of the high Whig world" Lord Acton belonged to an English Catholic family, but his paternal grandfather was the prime minister of the kingdom of Naples and Sicily and his maternal grandfather was a German nobleman On the Neapolitan court, where he was brought up in his infancy, fell the shadow of the court of St Petersburg On his father's death he was brought to England, where his mother's marriage with Lord Granville brought him into close contact with the high Whig world Educated in Germany, he came under the influence of Dollinger and established contact with a world of scholarship to which he would otherwise have been completely foreign He made journeys to Moscow, where his step-father, holding high diplomatic office, introduced him to Russian Civilization With France the young scholar was connected through many sources, and Tocqueville made a lasting impression on his thought It is probably correct to say that Lord Acton's life was too universal to be properly appreciated by the insular scholarship of the British Universities At any rate, the delayed recognition which his genius received in his own country requires an explanation The formative years of his life ended, according to Bishop Mathew, with his brief membership in the House of Commons, which introduced him to Gladstone and the Liberal circle. His historical reviews revealed his great intellectual powers and England gradually found herself compelled to accommodate her brilliant but unconventional son

A. C. B.

Britain's Way to Social Security —By Francois Lafitte Target for To-morrow Series Pp. 110 Pilot Press, London 1945.

In the first part of the work Mr Lafitte gives a brief outline of the conditions prevailing in the Victorian and Edwardian age. "In those days the worker was expected to fend for himself in all the contingencies of life—he could apply for charity or poor relief if all else failed. Thrift was his first line of defence" Between 1907 and 1911 however a number of enactments were put on the Statute book regarding free or Government subsidised medical aid and compulsory health insurance After the first world war, the social insurance services developed. But as in other fields big business houses practically captured the workng out of the Government Scheme.

The rules regarding control of "the society's activities" by members and running the "health insurance business without profit" were admittedly more or less make believe As however unemployment rose very high in this period, unemployment insurance was widely extended and came to include fifteen million individuals by 1938 Also the limits of drawing benefit were expanded Old age State Pensions for persons over 70 had been introduced on a non-contributory basis by Lloyd George in 1908 and these were linked with contributory pensions for people of age 65-70 in 1925 and other amenities were added by 1937.

The flows in the social insurance scheme in force at this period are enumerated by Mr Lafitte The main defects are that too many people are left out of such benefits and too many basic needs (like special expenses at child birth) are inadequately or not at all provided for There is also too much commercialism and waste and the benefits are too short in duration.

The report on Social Insurance presented by Sir William Beveridge in December 1942 attempted to remove these defects in the laws for social security. The Coalition Government in power at the time issued two White Papers in September 1944 setting out steps proposed to be taken by the Government, on the basis of this Report but with certain fundamental changes The present work sums up the Beveridge Plan and the war-time Coalition Government plan and discusses their relative merits It is well worth reading by all students of sociology.

K. P. C.

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

A NEW METHOD OF APPLICATION OF ACENAPTHENE

ACENAPTHENE and certain other chemicals were used in the production of polyploidy in *Cajanus* The method of application used was according to Kostoff as vapour and in solution in water Doubling of chromosome was neither noticed in *Cajanus* nor in Wheat and *Allium*[1], the materials on which Kostoff[1, 2] had succeeded To increase the effectiveness of the chemicals, solvents other than water were tried [3]

Different solvents for acenapthene as xylol, ether, and lard (animal fat) were used It has been pointed out[4] that a chemical can pass successfully in a cell when dissolved in a fatty solvent. Chemicals other than lard affected the seeds themselves so proved absolutely useless Lard was seen to be quite inactive in all the cases and the effects noticed were due to the chemicals dissolved in it. It proved to be the best solvent In this case one can prepare acenapthene solution of a desired concentration, while in case of water the concentration is uncontrollable. Such is the case with vapour treatment also. In case of lard the concentration of the acenapthene can be increased or decreased as desired and the experiment can run under control.

Method.—One per cent solution of acenapthene in lard was prepared. *Cajanus* seeds of B.A.M.4 types were coated with it The coated seeds were put in three plates Daily in day time they were kept in sun and at night removed to the laboratory One plate was taken after 7 days, and the solution removed The seeds were soaked in water for 24 hours and thereafter sown in moist sand for germination On germination the root-tips were taken and prepared for cytological studies The second plate was taken after 15 days and the third one after 30 days of treatment

FIG. 1

Result.—Clumping of chromosomes was the main feature of the treatment (Fig 1) Polynucleolate and binucleolate condition (Fig. 2) were also frequently

met with, due to the inhibition of the cell-wall formation. The most outstanding feature shown was the hypertrophy developed in case of 15 days treatment

FIG. 2

The size of the individual cells was increased very much. The growth was abnormal. The root-tips were swollen and not uniform in contour, but showed ridges and grooves. The 30 days of treatment proved detrimental to germination.

In addition to acenapthene, benzene, retene, flourene, and flourenthene were also used but it was noticed that acenapthene in lard produced the maximum effect It is thought possible that by varying the concentration of the solution and duration of treatment doubling of chromosome can be induced by this method.

SATYA PAL SINGH

Asansol College,
Asansol, 30-11-1946

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[2] Kostoff, D, *Current Science*, *7*, 108-110, 1938
[3] Nellei A Brown, *Phytopathology*, *32*, 1, 1942
[4] S. Sampath and S. P Singh, *Current Science*, *15*, No 8, 137, 1946.
[5] S. S. Rajan, Thesis submitted for the M Sc. (Agri-Bot), degree, 1946 (Benares Hindu University), 1946.

ON THE PROOF OF THE INVERSE SQUARE LAW: THE ABSOLUTE DETERMINATION OF *H, M, l* & *m* AND THE COMPARISON OF MAGNETIC MOMENTS

THE formulae for proving inverse square law (Gauss's method), for measuring H and M and for comparison of magnetic moments with a deflection magnetometer are usually obtained by neglecting l^2 or l^4. In order that this approximation may not introduce a large error it is necessary to place a magnet at a distance, many times its length, from the needle of the deflection magnetometer while noting the deflections. This makes the deflections small and increases the relative error in reading them. On the other hand if the magnet is placed near the needle we have no justification in neglecting l^2. Thus one gets stuck up and does not know how to improve the accuracy of measurements and yet neglect l^2.

The aim of this note is to show that it is absolutely unnecessary to neglect l^2 or even l^4 By a simple device, explained below, it is not only possible to *eliminate* l^2 but evalute it also. An important advantage in using the formulae derived below lies in the fact that all the deflections observed may differ a little from 45° in which position the deflection magnetometer is most sensative.

I THEORY OF THE NEW METHODS

For 'A' position of Gauss we have,

$$\frac{2Md}{(d^2-l^2)^2} = \mathrm{H} \tan\theta_A$$

$$\text{or } d^2 = \sqrt{\frac{2M}{H}} \cdot \sqrt{\frac{d}{\tan\theta_A}} + l^2 \quad . \quad . \quad (1)$$

which shows that if a graph be plotted between d^2 and $\sqrt{d/\tan\theta_A}$, taking the latter along x-axis, it will be a straight line whose slope is given by $m_A =$

$$\sqrt{\frac{2M}{\mathrm{H}}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and whose intercept on the positive side of the y-axis is l^2.

For 'B' position of Gauss, we get,

$$\frac{M}{(d^2+l^2)^{3/2}} = \mathrm{H} \tan\theta_B$$

$$\text{or} \qquad d^2 = \left(\frac{M}{H}\right)^{2/3} \times \left(\frac{1}{\tan\theta_B}\right)^{2/3} - l^2 \quad . \quad . \quad (3)$$

which shows that if a graph be plotted between d^2 and $\tan^{-\frac{2}{3}}\theta_B$, taking d^2 along y-axis, it will be a straight line whose slope is given by

$$m_B = \left(\frac{M}{H}\right)^{2/3} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and whose intercept on the negative side of the y-axis is equal to l^2.

II. ON THE PROOF OF THE INVERSE SQUARE LAW

(*i*) The equations (1) and (3) are both obtained on the assumption of the inverse square law. The fact that the graphs between d^2 & $\sqrt{d/\tan\theta_A}$ and d^2 & $\tan^{-\frac{2}{3}}\theta_B$ for the 'A' & 'B' positions of Gauss are found to be straight lines in actual practice, demonstrates the truth of the law.

In this method of graphs no approximation on account of the uncertainty about l is involved like the one mentioned by S. G. Starling.[1]

(*ii*) From the slopes of the graphs in the equations (2) & (4) it follows that $\frac{m_A{}^2}{m_B{}^{3/2}} = 2$ . . (5)

This formula is superior to Gauss's formula $\frac{\tan\theta_A}{\tan\theta_B} = 2$, firstly because it is independent of l^2 and secondly because it enables us to take the deflections lying between 30° & 60° with a corresponding increase in the accuracy of the measurements The two graphs may be plotted on the same graph paper for different values of d & θ and the slopes found out. Since the same values of d need not be used in the two positions the deflections in the 'B' positions can be made as large as those in the 'A' positions.

In an actual experiment the following mean deflections of an ordinary pivoted type deflection magnetometer (Pye make) were noted with a bar magnet of geometric length 10 cms placed at the following distances

d	θ_A	θ_B
15·0 cms	36·3°	15·6°
17·0 ,,	25·5°	11·1°
19·0 ,,	18·3°	8·1°
21·0 ,,	13·6°	6·0°

The mean values of the results as calculated from the above observations are:—author's formula: 2·004 and Gauss's formula: 2·422.

It will not be out of place to point out here that the ratio $\frac{\tan\theta_A}{\tan\theta_B} = \frac{2M/(d^2-l^2)^2}{M/(d^2+l^2)^{3/2}} = 2 \times \frac{(1+l^2/d)^{3/2}}{(1-l^2/d^2)^2}$ used in the Gauss's formula must always be greater than 2 as $(1+\frac{l^2}{d^2})^{3/2}$ is greater than 1 and $(1-\frac{l^2}{d^2})^2$ is less than 1 Even in the case of the selected example discussed by S. G. Starling[2] it is 2·012 ± a probable error of 1 in 150 in the reading of the deflections. Moreover since $\frac{l^2}{d^2}$ is to be neglected it is necessary to use a small magnet and place it at a large distance from the needle of an *exceedingly* sensative magnetometer. It is futile, therefore, to attempt to prove the inverse square law by Gauss's method with the magnetometers and magnets usually available in the college laboratories.

(*iii*) If we assume the inverse nth law instead of the inverse square law, the equation for the 'B' position of Gauss is

$$\frac{M}{(d^2+l^2)^{\frac{n+1}{2}}} = H \tan\theta_B$$

or $$d^2 = \left(\frac{M}{H}\right)^{\frac{2}{n+1}} \times \tan^{-\frac{2}{n+1}}\theta_B - l^2 \quad . \quad . \quad (6)$$

which shows that the graph between d^2 & $\tan^{-\frac{2}{n+1}}\theta_B$ should be a straight line Now it is an experimental fact that the graph between d^2 & $\tan^{-2/3}\theta$ is a straight line, hence $\frac{2}{n+1} = \frac{2}{3}$ and $n = 2$.

A similar argument may be used for the 'A' position of Gauss.

III. Absolute Determination of H & M

For this purpose two experiments are performed with the same magnet using the deflection and the vibration magnetometers to find $\left(\frac{M}{H}\right)$ and (MH)

For the evaluation of $\frac{M}{H}$ R. W Hutchinson[3] and and Worsnop & Flint[4] have derived slightly different formulae by neglecting the 4th and higher powers of $\frac{l}{d}$, while S G Starling[5] suggests an approximate method of eliminating 'equivalent length' from the deflections produced at any two distances of the magnet.

The best method for evaluating $\frac{M}{H}$ is to use the slopes of the graphs between d^2 & $\sqrt{d/\tan\theta_A}$ and d^2 & $\tan^{-\frac{2}{3}}\theta_B$ From equations (2) & (4) we get for

'A' position of Gauss, $\frac{M}{H} = \frac{1}{2}m^2$

'B' position of Gauss, $\frac{M}{H} = m_B{}^{3/2}$

Combining these results with $MH = \frac{4\pi^2 I}{T^2}$ obtained from the oscillation experiment, we get,

For 'A' position $H = \frac{\pi\sqrt{8I}}{T.\, m_A}$ and $M = \frac{\pi M_A\sqrt{2I}}{T}$ . . . . . (7)

For 'B' ,, $H = \frac{\pi\sqrt{4I}}{T.\, m_B{}^{3/4}}$ and $M = \frac{\pi m^{3/4}\sqrt{4I}}{T}$ . . . . . (8)

In the derivation of the above formulae no power of $\frac{l}{d}$ is neglected. They involve, therefore, no such approximation as the formulae of Hutchinson, Worsnop and Starling do. Hence they yield more accurate results.

In an actual experiment performed with a magnet of 30·5 cms. geometric length placed at a distance of 30 to 34·6 cms. from the needle of a deflection magnetometer Hutchinson's, Worsnop's and the author's formulae gave the mean value of H as 0·3666, 0·3127 and 0·3200 respectively.

The formula published by the author in '*Current Science*', Vol. 12, No. 4, p. 113, April 1943, is a particular case of the above general method because

$\dfrac{d_1^2 - d_2^2}{\sqrt{d_1/\tan\theta_1} - \sqrt{d_2/\tan\theta_2}}$ is equal to the slope of the graph between d^2 & $\sqrt{d/\tan\theta}$ for the 'A' positions of Gauss.

IV. Determination of $2l$

The equations (1) and (3) show that the intercepts on the positive and the negative sides of the y-axis of the graphs between d^2 & $\sqrt{d/\tan\theta_A}$ and d^2 & $\tan^{-\frac{2}{3}}\theta_B$ for the 'A' & 'B' positions respectively are each equal to l^2. Hence $2l$, the 'equivalent length' or 'magnetic length' of a magnet is equal to twice the square roots of these intercepts

V Determination of m

The ratio of M, the magnetic moment of a magnet, obtained in Part III to $2l$, the magnetic length of the magnet, evaluated as explained in Part IV gives m, the pole strength of the magnet

VI Comparison of Magnetic Moments

(i) *Deflection Method*

Denoting the slopes of the graphs for 'A' & 'B' positions of two magnets of magnetic moments M_1 & M_2 by m_{A1}, m_{A2} and m_{B1}, m_{B2}, we get from eqns (2) & (4)

For 'A' position, $$\frac{M_1}{M_2} = \left(\frac{m_{A_1}}{m_{A_2}}\right)^2 \quad . \; . \; . \qquad (9)$$

For 'B' ,, $$\frac{M_1}{M_2} = \left(\frac{m_{B_1}}{m_{B_2}}\right)^{3/2} \quad . \qquad (10)$$

As the formulae (9) & (10) are independent of l, the magnets may have any geometric lengths and may be placed at any distance from the needle of the deflection magnetometer as is necessary to reduce the relative error in reading the deflections.

(ii) *Null Method*

For 'B' position of Gauss, we have, for two magnets of any lengths

$$\frac{M_1}{(d_1^2 + l_1^2)^{3/2}} = \frac{M_2}{(d_2^2 + l_2^2)^{3/2}}$$

or $$\left(\frac{M_1}{M_2}\right)^{3/2} = \frac{d_1^2 + l_1^2}{d_2^2 + l_2^2} = \text{B (say)}$$

or $$d_1^2 = \text{B}d_2^2 + (\text{B}l_2^2 - l_1^2)$$

and $$\frac{M_1}{M_2} = \text{B}^{3/2} \quad . \; . \qquad . \; . \; . \qquad (11)$$

Since $(\text{B}l_2^2 - l_1^2)$ is a constant for any two magnets, the graph between d_1^2 & d_2^2 will be a straight line If d_2^2 is taken along x-axis, the slope of the graph will be equal to B which when raised to the power $\frac{2}{3}$ gives the ratio of the magnetic moments.

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24-12-1946.

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[3] "Intermediate Electricity", pp 118, 119, 1941.

[4] Advanced Practical Physics", p 441, 1927.

[5] "Electricity and Magnetism for Degree Students", pp 25-28, 1941

VEGETABLE *GHEE*—ITS NUTRITIVE VALUE*

Recently there has been much discussion regarding further production of vegetable ghee in our country, and there has been much difference of opinion regarding its nutritive value

Apart from the fact that vegetable ghee does not contain any vitamin (A and D), its dietetic value has been measured from various aspects

Fatty acids being fully saturated by the process of hydrogenation, it can be easily conceived that its digestibility would be considerably diminished Experiments conducted on lower animals fed with the vegetable ghee as the only source of fat, within a limit of 5—10 per cent, have proved this point

Besides the above mentioned point, it has been observed that presence of saturated fatty acids renders the absorption of other substances, like Protein and Carbohydrate, very difficult, probably (*i*) by forming a hard indigestible coating round these materials and (*ii*) by adversely affecting the secretions of the stomach and intestines. As a result of this, foods are not properly digested and dyspepsia sets in.

In vitro experiments it has been found that saturated fatty acids are affected by bile with the greatest difficulty *In vivo* experiments, conducted on rats, it has been found that the hydrogenated fats would be deposited in the liver and produce a condition of fatty liver

Experiments conducted on lower animals, like rats, with hydrogenated fat have shown that the normal growth of the animals is adversely affected. And it is well explained from the observations recorded before.

* Paper read at a joint meeting of the Physiology and Medical and Veterinary Sciences Section of the 33rd session of the Indian Science Congress held at Bangalore, January, 1946.

A very peculiar phenomenon has been observed that with the increase in the percentage of the hydrogenated fat in the diet of the animals (rats) there is a corresponding decrease in the number of the issues. Carrying this feeding experiment over a long period, it has been also found that in successive generation there is a gradual decrease in the number of issues. In all probability, this is due to two reasons (i) absence of Vitamin-E, the antisterility factor and (ii) presence of some substance (? chemical) which is directly responsible for producing sterility by affecting the female sex hormones.

Various attempts have been made to increase the nutritive value of vegetable ghee. But unfortunately most of these trials have been based on the assumption that the absence of vitamins is the only cause. But a simple statement might settle the whole question—vitamins are practically destroyed when ghee is raised to boiling point, as is the usual process of cooking. Hence there is no justification to assume that the difference in nutritive value would be only due to absence of vitamins in vegetable ghee.

Apart from this simple experiment, there are other experiments which also go to show that addition of vitamins in vegetable ghee fails to raise the nutritive value to the same extent as buffalo or cow ghee. And the following reasons might be ascribed for this—(i) non-digestibility of the hydrogenated fat, combined with the adverse effects on various digestive processes, as stated before, (ii) carotin, which is most commonly used for vitaminizing, is absorbed with great difficulty, and it is absorbed mostly in combination with unsaturated fatty acids, (iii) deterioration of Vitamin (A) in butter and ghee is fairly quick, but the rate of deterioration when mixed with vegetable ghee is much more rapid.

From these experiments, it seems that vegetable ghee itself is of a very low nutritive value, and attempts so far made to raise its value by addition of vitamins are also practically of no use.

N. K. Bose

49, Rajpur Road, Delhi.
22-2-1947

NATIONALISATION OF THE MIO

Various writers have expressed grave concern over the policy of drastic retrenchment adopted by the authorities of the Mathematical Instrument Office, Calcutta. It now appears that cooperation of your journal in this respect with the efforts of the Association of Scientific Workers (India) and the MIO Employees' Association has not been in vain.

It is understood that the Superintendent of the MIO has given assurance that "No further reduction in staff is contemplated in the MIO during 1947-48". While expressing delight at this assurance one may feel distressed to recall that no arrangements have been made to utilize the valuable services of the two-thirds of the personnel who have already been thrown out of job when they could have been considered as the assets of the MIO.

Besides, it is not clear from the assurance of the Superintendent whether any programme for expansion of the organization is on the way. As a matter of fact, this point was specially stressed by a reputed scientist who went to inspect the MIO as an official visitor in October last. It seems that no heed has been given to his valuable recommendations. It shall be regretted by all that these organizations are not fully mobilized for the betterment of the country in spite of the assurances of our national leaders—who are at the helm of the government today—that salvation of India lies in her complete industrialization.

We would not be surprised if reduction of technical personnel is started afresh after 1947-48, though this would be a disastrous move indeed. The reason shown for such reduction is that the materials produced during the war are of not much value during the peace. At the same time, I am informed, various types of mathematical and scientific instruments, worth Rs 14½ lakhs, which have been and can be manufactured by the MIO have been indented by it from the Director General, Instrument supply Department, London. It would not be out of place to ask for an official enquiry in this matter since there is a standing government circular that prior to any provincial or central government ordering for scientific instruments from abroad should find out whether the MIO are able to manufacture the same. And the MIO is 'naturally' unable to manufacture these instruments if reduction in personnel and dismantling of mother instruments are indulged in.

We feel now as never before that a bold policy of nationalization of such concerns as the MIO and operating them under the guidance of Indian scientists should be the order of the day. As we have seen in the recent past, the country does not lack in such scientists who can also serve as capable executives.

It is understood that the technical employees of the MIO are eager to place before an authoritative body facts related to the MIO with suggestions born out of their experience as to how their services should be best utilized for the benefit of the country. To

let such an opportunity go by may prove in the long run to be an error causing irreparable loss to the nation as a whole.

N Mukherjee

Calcutta, 5-4-1947.

THE SPECTROGRAPHIC DETERMINATION OF GALLIUM IN INDIAN BAUXITE BY THE CATHODE LAYER ARC.

The carbon arc cathode layer method of spectrographic analysis, developed by Mannkopff and Peters[1] in Gottingen has been followed for the quantitative estimation of gallium in nine different samples of Indian bauxite. Goldschmidt and Peters[2] determined semi-quantitatively the gallium content in different aluminium containing rocks and minerals (not Indian bauxite) with the cathode layer method, each result being given has a wide range of values as 0 001—0 01 per cent i e., 10^{-3}—(10^{-4}) per cent, nearer to the first figure

Hilger large quartz spectrograph (E 1) of very suitable dispersion and Twyman-Simeon lens arrangement[3] are employed in the present investigation Standard mixtures are prepared by adding standard solutions of Ga in gallium-free aluminium hydroxide of the following compositions · 0·05 per cent, 0 02 per cent, 0·01 per cent, 0·007 per cent, 0·005 per cent, 0·003 per cent, 0 001 per cent and 0 0005 per cent Standard spectrum plates of gallium are prepared from these mixtures The "Kino-Homogen" carbon rods which are very impure and contain above all traces of gallium as impurities are purified in this laboratory, the final pure product being completely free from the minute traces of Ga. The cathode has a crater of 5 mm depth and 3 mm inner diameter with a wall thickness of 0 7 mm. in which a mixture of 3 mg standard mixture and 3 mg. pure carbon powder is introduced For each spectrum 150 seconds exposure is given using current of 9 5 amps. at 220 v d c. Observations under a comparator of the standard spectra indicate that the Ga-line 2943 7 A° is most sensitive over the ranges of concentrations being used The spectra of the nine different samples of Indian bauxite are photographed maintaining a consistent operating technique, the shape of the cathode, amount of sample, exposure, development and all other variable factors being always kept constant.

The blackness of the Ga-line, 2943·7A° in the standard spectra is measured with a photoelectric non-recording microphoto-meter and expressed in arbitrary units from the scale of the galvanometer The background correction is accomplished by subtracting the blackening value of the background taken adjacent to the Ga-line from that of the Ga-line. A calibration curve is then drawn with the corrected blackening values of the Ga-line in the standard spectra plotted as ordinates against concentrations of gallium. In the same way the blackness of the Ga-line in the different sample spectra is measured and gallium concentrations in the samples are determined from the standard calibration curve.

TABLE I

Bauxite No	Locality	Percentage of gallium
291	Salgipat, N Lohardaga, Bihar	0 002
737	N. E of Amarkantak, S Rewah	0 0035
788A	N W of Radhanagri	0 0043
797	Yelurgarh Fort, Bombay	0 003
1128	Surganj State	0 007
1142	"	0 008
4696	Katni, Jubbulpore, C P	0 0055
5038	1 mile N W of Dhagarvadi, Kolahpur, Bombay ..	0 0026
5100	Salal, Riasi Tehsil, Kashmir	0 007

Our best thanks are due to Prof. K Banerjee of the Indian Association for the Cultivation of Science for his permission to use the microphotometer and to Mr R Sen, M Sc for his kind help in photometric measurement

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21-4-1947

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BLOOD CLOTTING FACTOR IN CASTOR SEED

(*RICINUS COMMUNIS*)

Thromboplastin preparations are generally obtained from animal sources like brain, liver and lung ; and rarely have the plants been investigated for the presence of such factors The disadvantages of "Thromboplastin" preparations from animal sources for use in estimating the prothrombin type have been fully discussed by several workers[1, 2].

It is therefore desirable to explore other sources of "Thromboplastin" which are more suited for use in the study of the coagulation of blood.

The only work so far mentioned in literature on the occurrence of such factors in plants is that of Bose and Roy[3, 4] who isolated two different neutral constituents from *Eupatorium ayapana,* which induce the coagulation of blood plasma.

Dyckerhoff *et al*[5] have also reported the occurrence of blood clotting factor in yeast

The present note relates to the presence of a factor in castor seed which resembles the "Thromboplastin" of animal tissues and Russel Viper venom and also "Thrombokinase" from yeast.

This factor which can be extracted with water from defatted castor seed meal induces the coagulation of blood plasma in presence of calcium The nature and behaviour of this factor on blood coagulation has been compared with the thromboplastic activity of Russel Viper venom. The factor present in castor seed does not coagulate the blood plasma in absence of calcium and in this respect resembles both thromboplastin of animal tissues and thrombokinase from yeast. The blood clotting activity of this factor increases on keeping the aqueous extract at 8-10°C In this respect it resembles thrombokinase from yeast. The activity of the aqueous extract decreases on dialysis or ultra-filtration

Further investigation on the purification and chemical nature of the factor is in progress.

Our thanks are due to Prof. V Subrahmanyan for his kind interest in this investigation.

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Bangalore, 24-4-47.

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INVESTIGATION ON 'FICOSTEROL',A STEROL OCCURRING IN *FICUS BENGALENSIS*

The latex from *Ficus Bengalensis,* the largest tree growing in the plains in all parts of India has long been known to possess some beneficial effect in some troubles of the gonadotropic glands. Work has therefore been undertaken to see if there is any steroidal compound in this tree and if this compound might act as the precursor of some gonadotropic principles.

By working up the unsaponifiable matter of the milky juice collected from the stems of the leaves and twigs of *Ficus Bengalensis,* it has been possible to isolate a sterol like compound of the probable formula $C_{29}H_{50}$ This substance forms beautiful star like crystals from ethyl alcohol-methylalcohol ethylacetate mixture (4 2 · 1) and the name 'Ficosterol' has provisionally been proposed for the substance.

Properties (Chemical and Physical).—Ficosterol has a very sharp melting point of 135°C and is highly soluble in most of the organic solvents It is dextrorotatory and has a specific rotation of $[\alpha]_D = +63{\cdot}59$ in chloroform The molecular weight as determined by the cryoseopic method with benzene as solvent has been found to be 410 leading to a probable formula $C_{29}H_{50}$ for this new compound.

It gives some of the characteristic colour reactions for sterols with Liebermann Burchard reaction, producing a greenish yellow colour which gradually changes to orange with intense green flourescence. In Salkowski's reaction, the chloroform layer remains colourless while sulphuric acid layer changes from yellow through orange to red with green flourescence With the new sensitive colour reaction[1] ficosterol gives green, yellow and orange coloured rings, one just below the other, the upper layer remaining colourless. Ficosterol does not form any digitonide.

Ficosterol is an unsaturated compound with but one double bond in it Its iodine value according to a modified Hanu's method is 65, one double bond requiring 61 3 as the iodine value. The number of bromine atoms which enter a molecule of ficosterol, on bromination in carbon tetrachloride solution is two. The bromo compound has been isolated, and the results of bromine estimation from the ficosteryl-di-bromide gives a further confirmation of the previous view regarding the empirical formula of ficosterol.

Substance taken—·0600 gms., Ag Br formed = ·0391 gms. Ag Br calculated for $C_{29}H_{50}Br_2$ = ·0393 gm.

Several derivatives of ficosterol have also been prepared, *e.g.*, acetyl deriv. (m.p. 125°C and sp. rotation in chloroform $[\alpha]_D^{30} = +65{\cdot}4$) ; benzyol deriv. (m.p. 187°C and sp. rotation in chloroform $[\alpha]_D^{30} = +108{\cdot}1$) ; 3 : 5 dinitrobenzoyl deriv. (m.p. 145-146°C) ficosteryl-dibromide (m.p. 170°C) and bromoficosteryl acetate (m.p. 157°C).

Oxidation.—By means of oxidation with cupric oxide in the lines suggested by Diels[2] ficosterol gives rise to ficostenone which melts at 105°C thus showing

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10-7-62		
17 FEB 1988		

S. C. P.—1/8/47 P. J.-3 5-48-2000